147-053

1

DOCUMENTATION OF DECISION-AIDING SOFTWARE:

RAM SYSTEM SPECIFICATION

DECISIONS AND DESIGNS INC.

Dorothy M. Amey
Phillip H. Feuerwerger
Roy M. Gulick

September 1979

N00014-79-C-0069

ADVANCED ARPA DECISION TECHNOLOGY PROGRAM

CYBERNETICS TECHNOLOGY OFFICE
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Office of Naval Research • Engineering Psychology Programs

DOCUMENTATION OF DECISION-AIDING SOFTWARE:

RAM SYSTEM SPECIFICATION

by

Dorothy M. Amey, Phillip H. Feuerwerger, and Roy M. Gulick

Sponsored by

Defense Advanced Research Projects Agency
ARPA Order 3469

September 1979

DECISIONS and DESIGNS, INC.
Suite 600, 8400 Westpark Drive
P.O.Box 907
McLean, Virginia 22101
(703) 821-2828

CONTENTS

FIGURES

RAM SYSTEM SPECIFICATION

1.0 INTRODUCTION

1.1 Purpose of the System Specification

The RAM System Specification is a technical document written for software development personnel. Together with the RAM Functional Description, it guides the software development effort by identifying the functional requirements and by providing structured logic diagrams that depict the flow, control, and processing of information within the system.

The system specification is generic and is intended to guide and facilitate the preparation of the language-specific program documentation and coding that are necessary to implement and operate RAM at an installation.

1.2 References

1.2.1 IBM, HIPO--A Design Aid and Documentation Technique. Technical Publication GC20-1851-0. White Plains, New York: IBM, October 1974.

1.2.2 Amey, Dorothy M.; Feuerwerger, Phillip H.; Gulick, Roy M. Documentation of Decision-Aiding Software: RAM Functional Description. McLean, Virginia: Decisions and Designs, Inc., September 1979.

1.2.3 Amey, Dorothy M.; Feuerwerger, Phillip H.; Gulick, Roy M. Documentation of Decision-Aiding Software: RAM Users Manual. McLean, Virginia: Decisions and Designs, Inc., September 1979.

1.3 Terms

1.3.1 RAM - RAM is an abbreviation for Resource Allocation Model, reflecting the system's major area of applicability.

1.3.2 HIPO - The specification uses the standard Hierarchy plus Input-Process-Output (HIPO) diagramming technique to depict the structural design and logical flow of the system. A legend explaining the HIPO diagramming symbols is included. Reference 1.2.1 provides a complete description of the HIPO documentation technique.

2.0 DESIGN DETAILS

2.1 Background

Systems development personnel should refer to the RAM Functional Description, reference 1.2.2, in conjunction with the documentation contained in this specification. The functional description details the resource allocation model implemented by RAM and discusses the specific functions that the software performs. In addition, systems development personnel may wish to refer to the RAM User's Manual, reference 1.2.3.

2.2 General Operating Procedures

RAM is a menu-driven system. That is, the system is designed to interact with the user by presenting a sequential hierarchy of menus and asking the user to respond by selecting one option from the current menu. If the user does not select one of the menu options, the system displays the previous menu. In this manner, the user moves up and down the hierarchy, as desired. Whenever data entry is required as a result of option selection, the system specifically requests the data and specifies the format.

The system is also designed to be generally forgiving of procedural errors by the user.

2.3 System Logical Flow

RAM is a hierarchically structured, modular system. The system structure and logical flow lends itself to presentation in the form of HIPO diagrams, which are contained in this document.

The main purpose of the HIPO diagrams is to provide, in a pictorial manner, the complete set of modular elements necessary to the operation of RAM including all input, output, and internal functional processing. This is done by displaying input items to the process step which uses them, defining the process, and showing the resulting output of the process step.

The documentation diagrams are designed and drawn in a hierarchical fashion from the main calling routines to the detail-level operation/calculation routines. Extended written descriptions are given below a HIPO diagram whenever it is deemed necessary.

A complete explanation of the symbolic notation used in the HIPO diagrams is given in reference 1.2.1. An abbreviated legend for the symbols used in this specification is given in Figure 2-1. Note that:

a. External subroutines appear partly in the process block and partly out. Internal subroutines are shown within the process block.

b. Overview diagrams show general inputs and outputs only, whereas detail/subroutine-level diagrams show specific input/output tables and/or displays.

c. Rectangular boxes inside the input/output block areas are generally used to denote single data items. Two or more boxes are grouped to show several data items are input/output.

d. Rectangular boxes inside the process block indicate repetitive subprocesses.

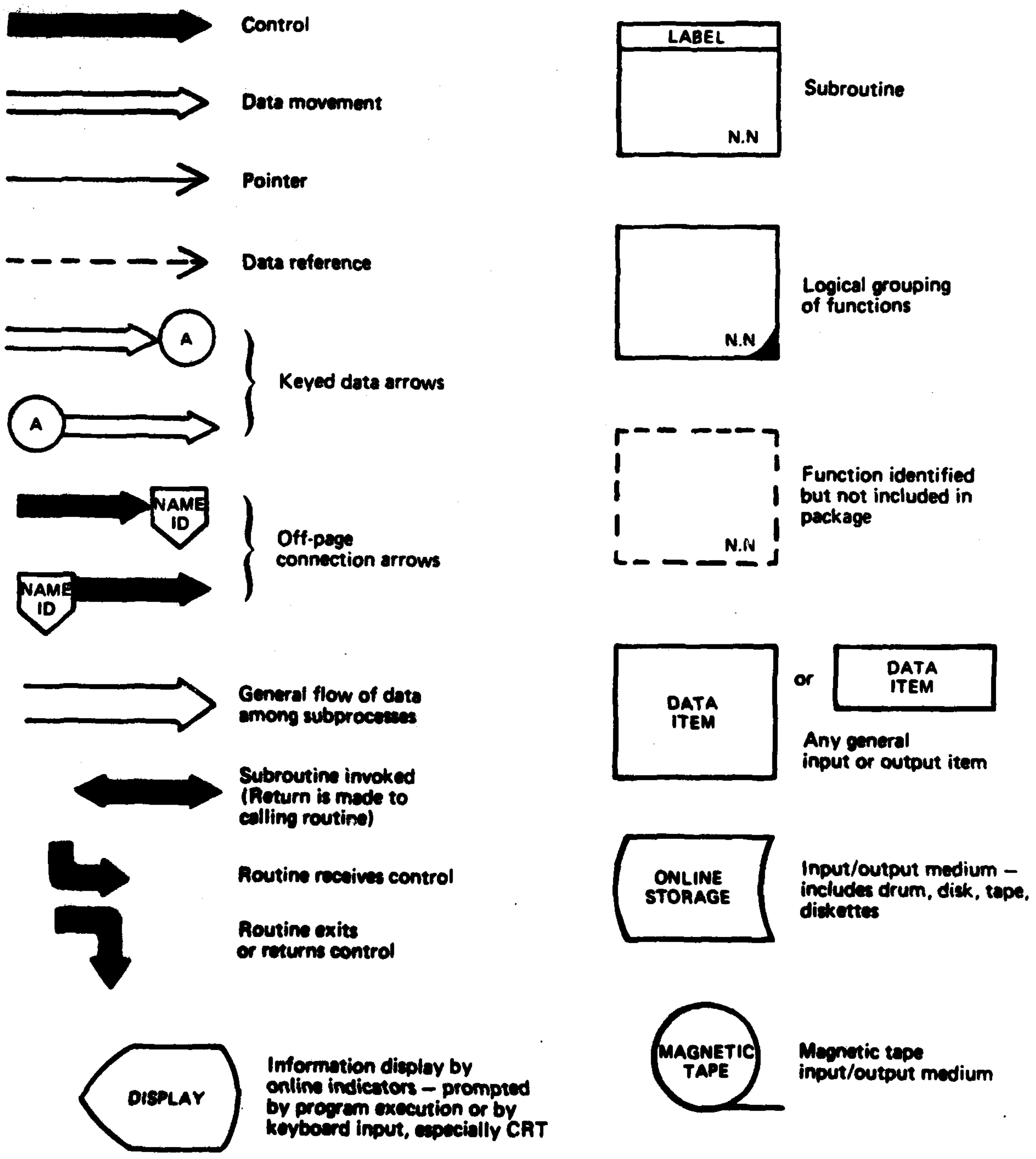

Control
Data movement
Pointer
Data reference
A
A
Keyed data arrows
NAME ID
NAME ID
Off-page connection arrows
General flow of data among subprocesses
Subroutine invoked (Return is made to calling routine)
Routine receives control
Routine exits or returns control
DISPLAY
Information display by online indicators – prompted by program execution or by keyboard input, especially CRT
LABEL
N.N
Subroutine
N.N
Logical grouping of functions
N.N
Function identified but not included in package
DATA ITEM
or
DATA ITEM
Any general input or output item
ONLINE STORAGE
Input/output medium – includes drum, disk, tape, diskettes
MAGNETIC TAPE
Magnetic tape input/output medium

Figure 2-1

LEGEND OF HIPO SYMBOLS

The HIPO diagrams appear in the next section, which completes the system specification.

2.4 HIPO Documentation

The HIPO diagram identification numbers and figure numbers used in this section stand alone; i.e., they start with 1.0, increase hierarchically, and are independent of the numbering scheme used to this point in this document.

The RAM system comprises two subsystems: BUILDRAM, which builds and exercises the resource allocation model, and REPRAM, which produces various reports based on the model and its data. Figure 2-2 is the system structure chart. Figures 2-3 and 2-4 are the subsystem charts and represent the overall program logic flows in visual tables of contents. The Visual Table of Contents shows the hierarchical structure, the functional description labels, and the diagram (chart) identifiers of the functions implemented by the RAM subsystems.

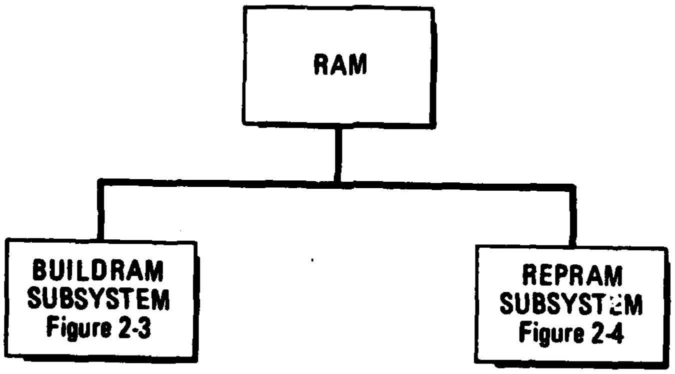


Figure 2-2
RAM SYSTEM OVERVIEW

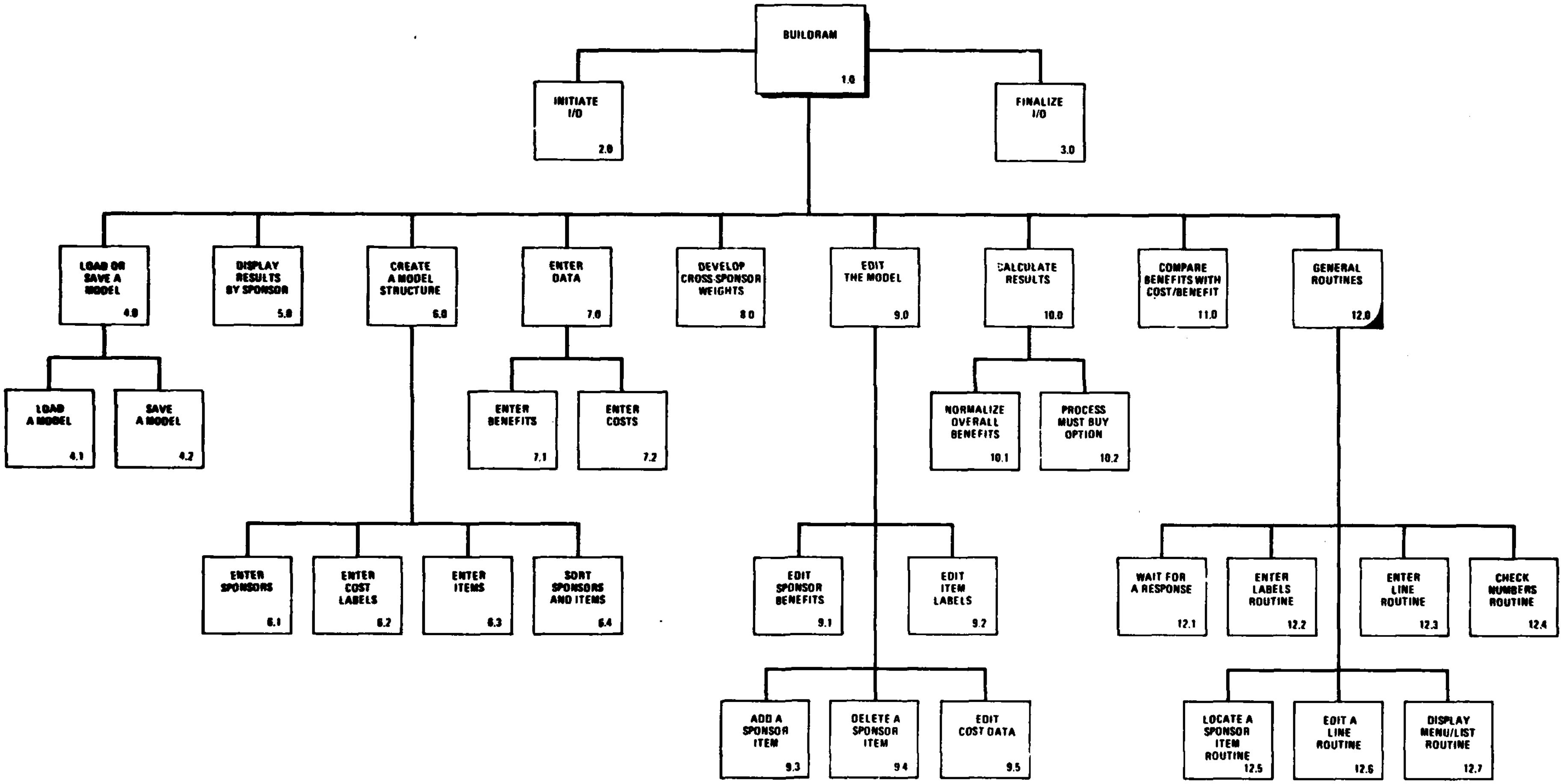


Figure 2-3

BUILDRAM SUBSYSTEM OVERVIEW AND VISUAL TABLE OF CONTENTS

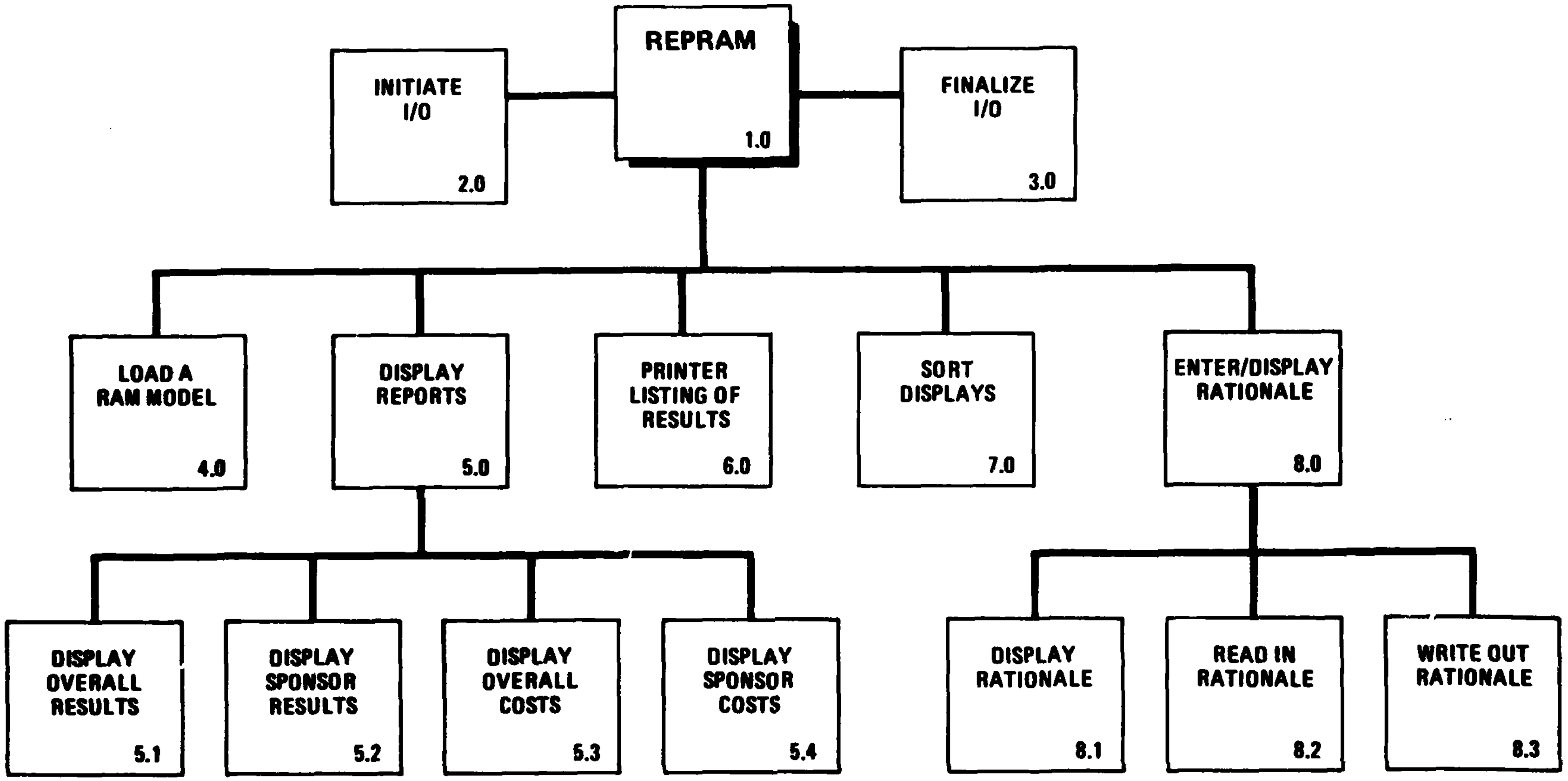
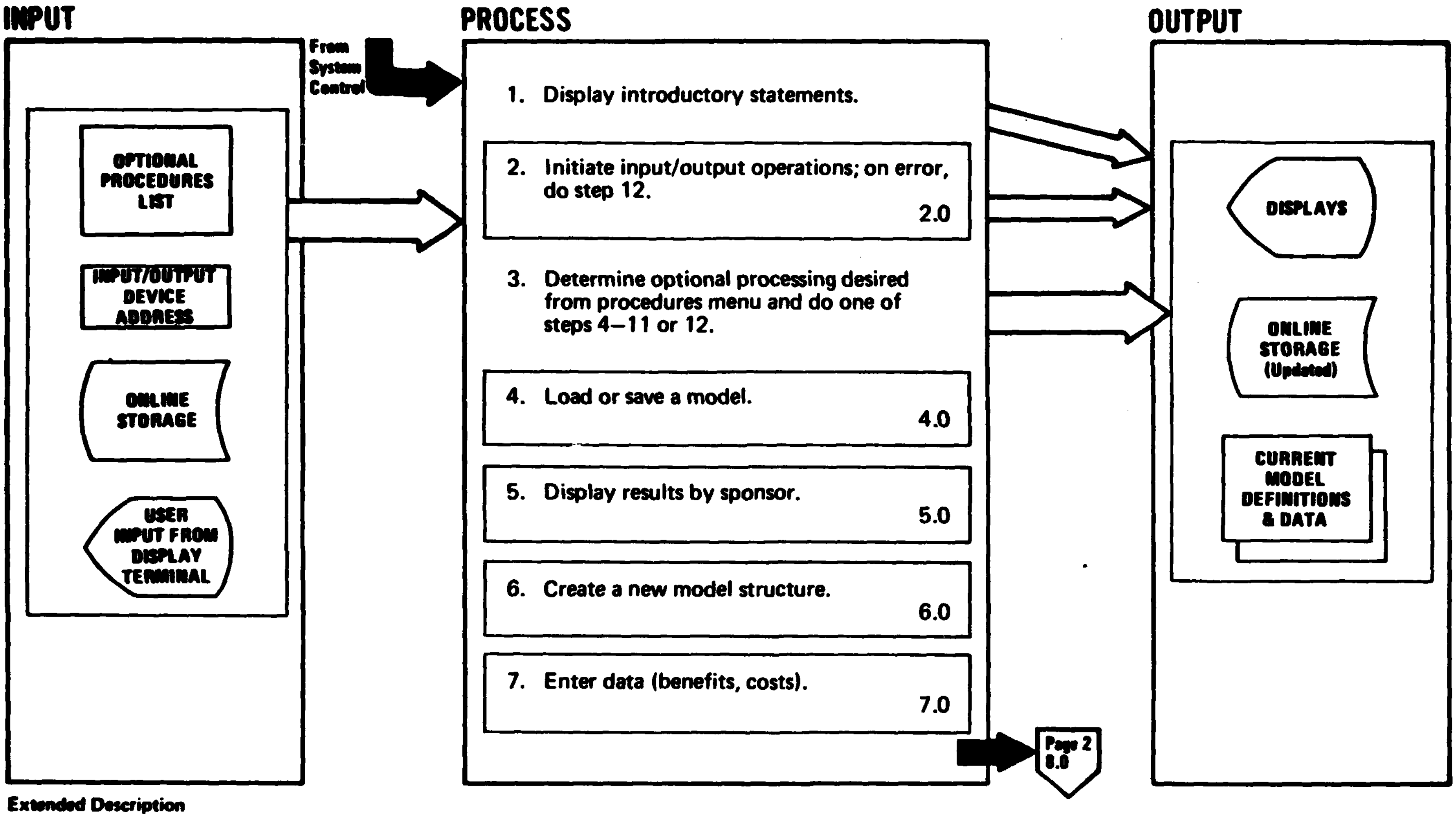


Figure 2-4

REPRAM SUBSYSTEM OVERVIEW AND VISUAL TABLE OF CONTENTS

System/Program: BUILDRAM Name:

Diagram ID: 1.0 Description BUILDRAM (RAM Build/Display) Page: 1 of 2



1. Display introductory statements.
2. Initiate input/output operations; on error, do step 12. 2.0
3. Determine optional processing desired from procedures menu and do one of steps 4–11 or 12.
4. Load or save a model. 4.0
5. Display results by sponsor. 5.0
6. Create a new model structure. 6.0
7. Enter data (benefits, costs). 7.0

Extended Description

The BUILDRAM subsystem allows the creation of a resource allocation model (a cost/benefit analysis model), the calculation of resulting cost/benefit (C/B) ratios, the rank ordering of these C/B ratios and the display and storage/retrieval of the calculated results.

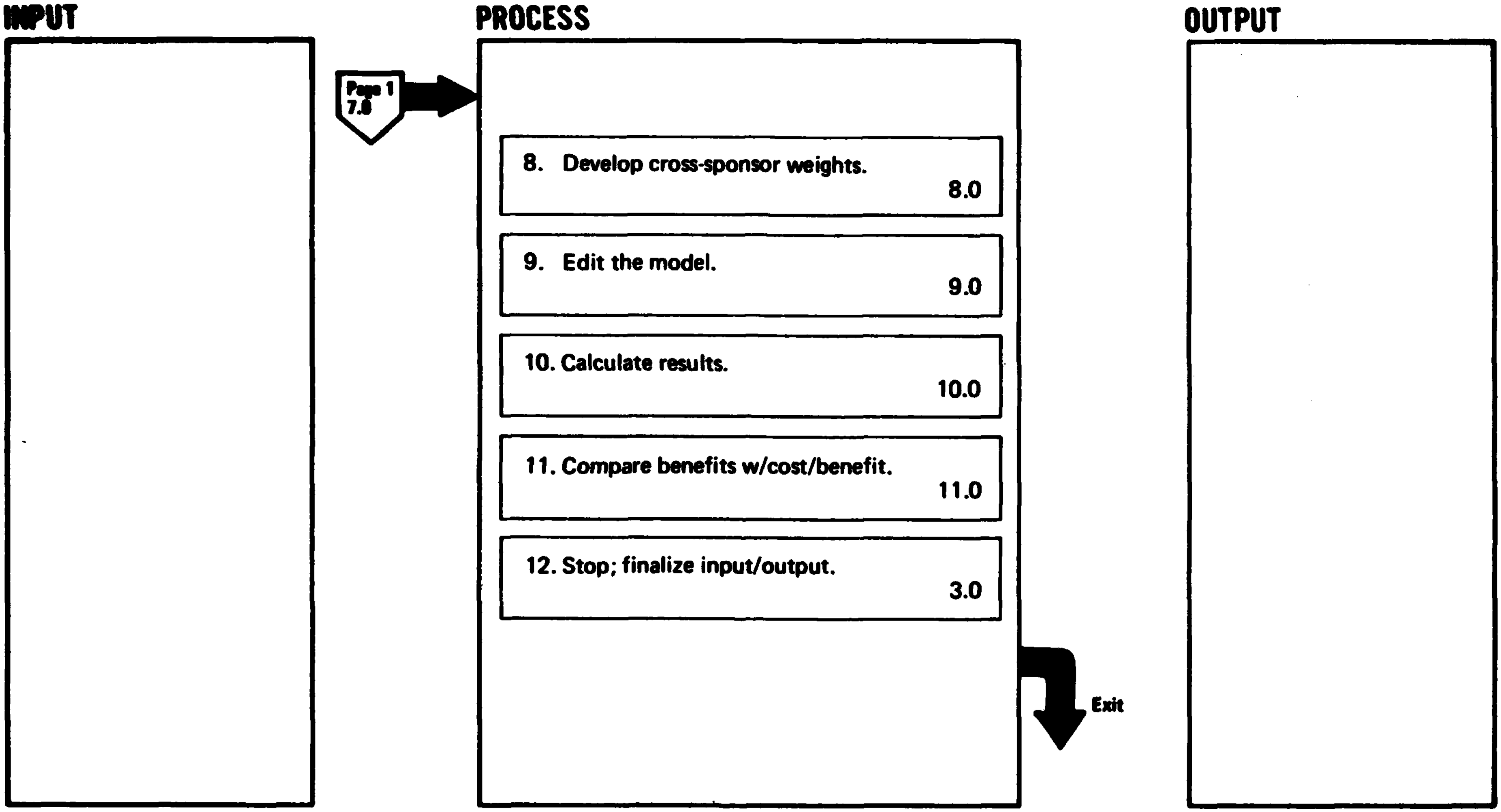
Input/output devices are made ready for use by the RAM program in step 2 and they are freed by processing in step 12.

Functional processing begins by having the user input a selection from an optional procedures list (MENU). Once the selected processing is completed, the same menu is displayed again and the user may select another process (or the same one again).

This means that procedures 4–11 are repetitive in structure. These functional subprocesses are described in detail in diagrams 4.0 through 11.0.

System/Program: BUILDRAM Name:

Diagram ID: 1.0 Description BUILDRAM (RAM Build/Display) Page: 2 of 2



8. Develop cross-sponsor weights. 8.0

9. Edit the model. 9.0

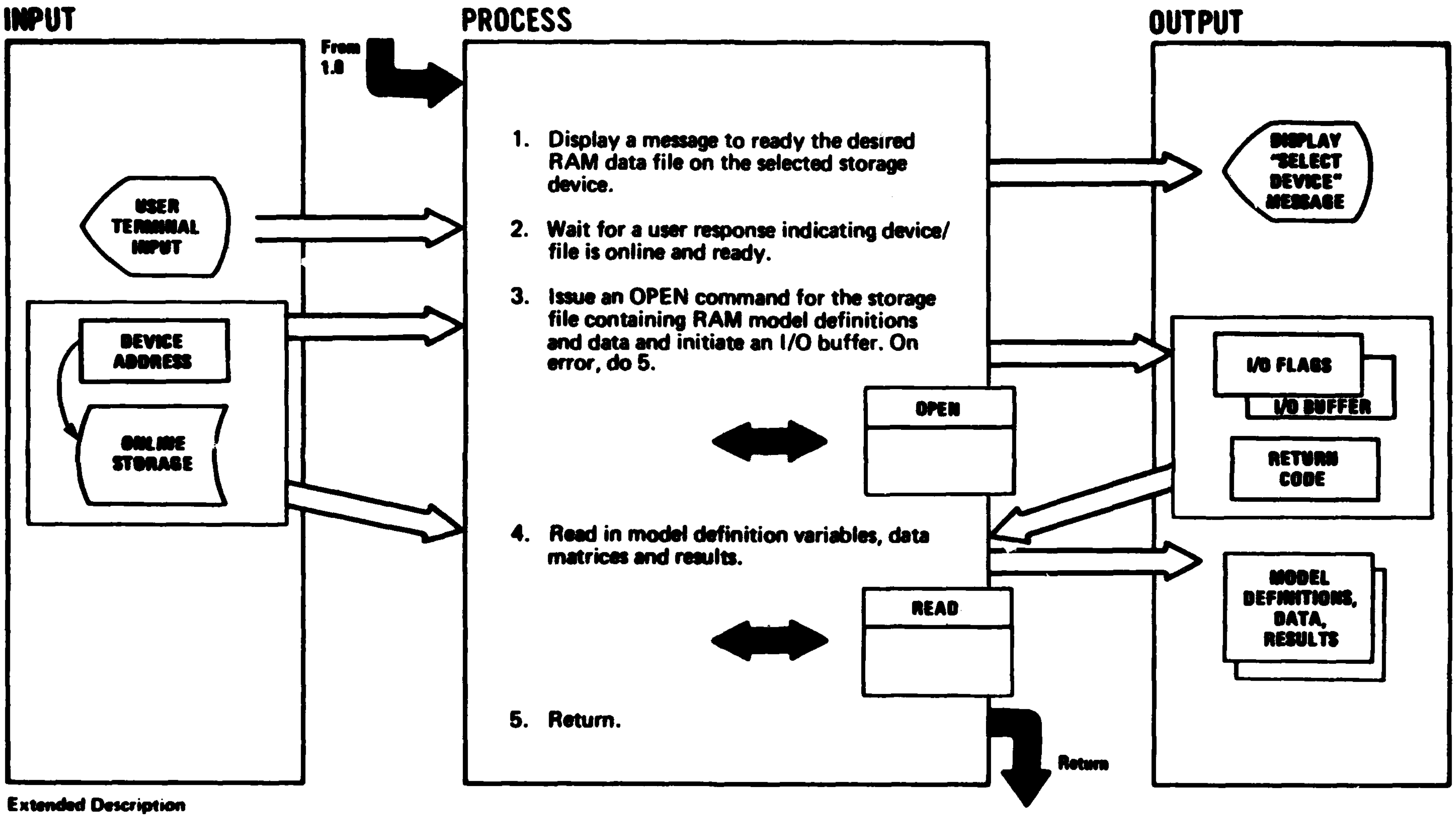
10. Calculate results. 10.0

11. Compare benefits w/cost/benefit. 11.0

12. Stop; finalize input/output. 3.0

System Program: BUILDRAM Name: ________

Diagram ID: 2.0 Description Initiate I/O Page: ____ of ____



1. Display a message to ready the desired RAM data file on the selected storage device.

2. Wait for a user response indicating device/file is online and ready.

3. Issue an OPEN command for the storage file containing RAM model definitions and data and initiate an I/O buffer. On error, do 5.

4. Read in model definition variables, data matrices and results.

5. Return.

Extended Description

1. The device address of online storage which contains the RAM data and model definitions is available at the start of program processing. It is either encoded in the program or requested from the user. It is assumed that only one RAM data set is available per dev/file address (i.e. diskette, drum cylinder, etc.)

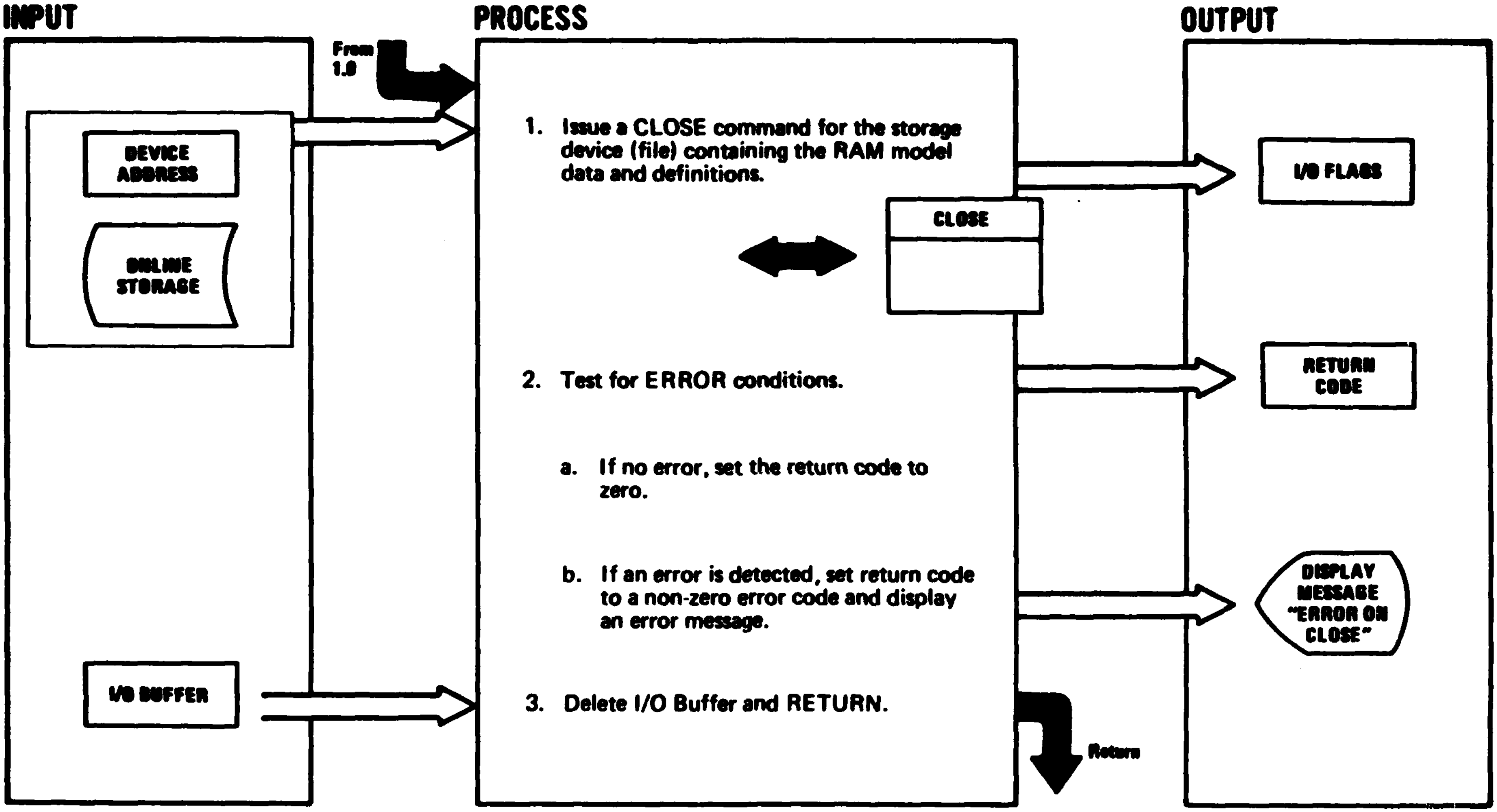
3. A system device OPEN command is required in order to access the RAM model and data. The interface with the system OPEN routine should be OPEN's setting of I/O flags in (or adjacent to) an I/O buffer area to denote the success or failure of access to the device.

If an error condition is detected, a non-zero error code is returned to the caller.

4. Model variables are read according to a preset order which is identical to the manner in which the variables are stored (see diagram 4.2).

System/Program: BUILDRAM Name:

Diagram ID: 3.0 Description Finalize I/O Page: 4



1. Issue a CLOSE command for the storage device (file) containing the RAM model data and definitions.

2. Test for ERROR conditions.

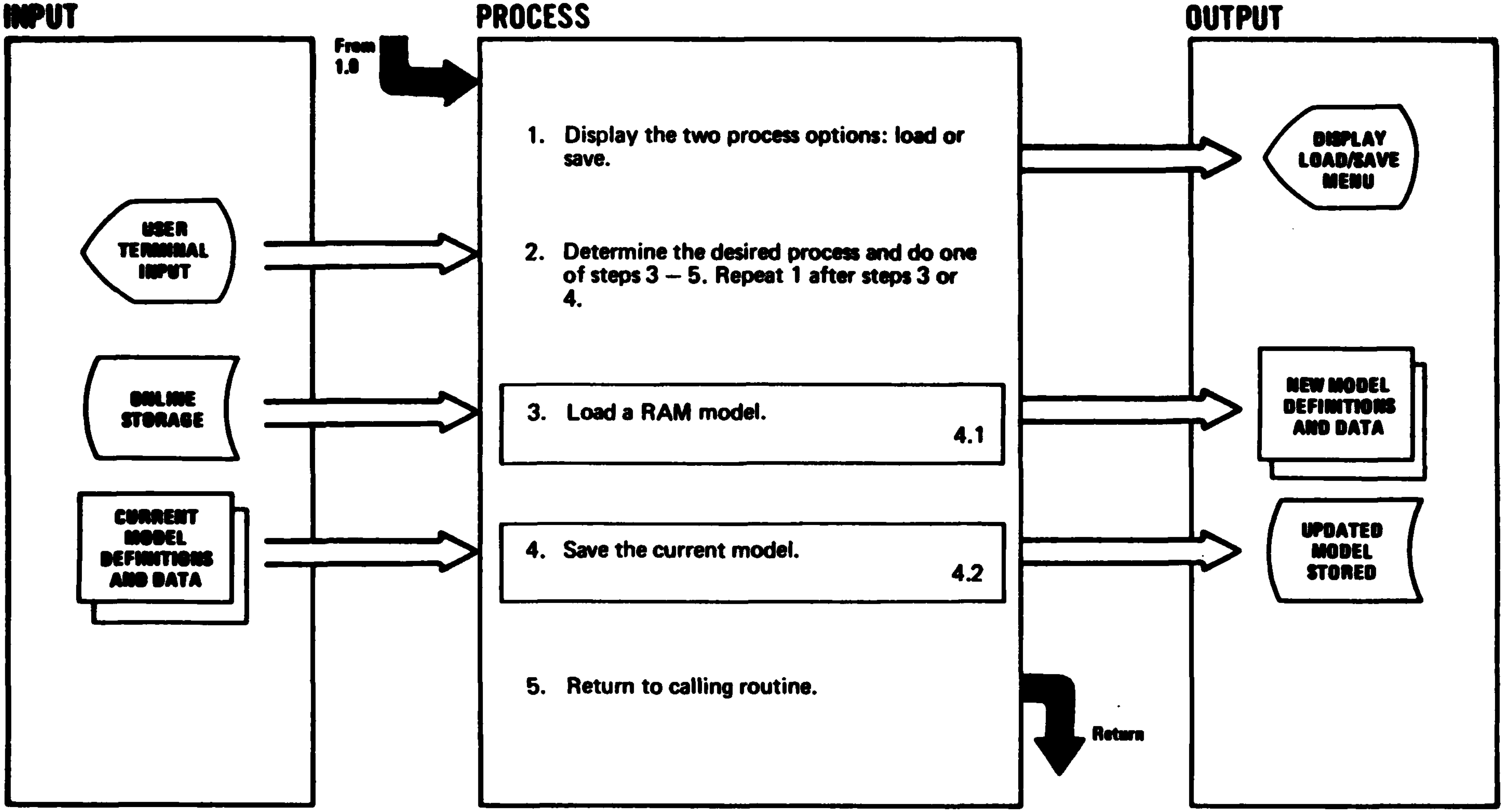
   a. If no error, set the return code to zero.

   b. If an error is detected, set return code to a non-zero error code and display an error message.

3. Delete I/O Buffer and RETURN.

System/Program: BUILDRAM Name:

Diagram ID: 4.0 Description Load or Save a Model Page: of



1. Display the two process options: load or save.

2. Determine the desired process and do one of steps 3 – 5. Repeat 1 after steps 3 or 4.

3. Load a RAM model. 4.1

4. Save the current model. 4.2

5. Return to calling routine.

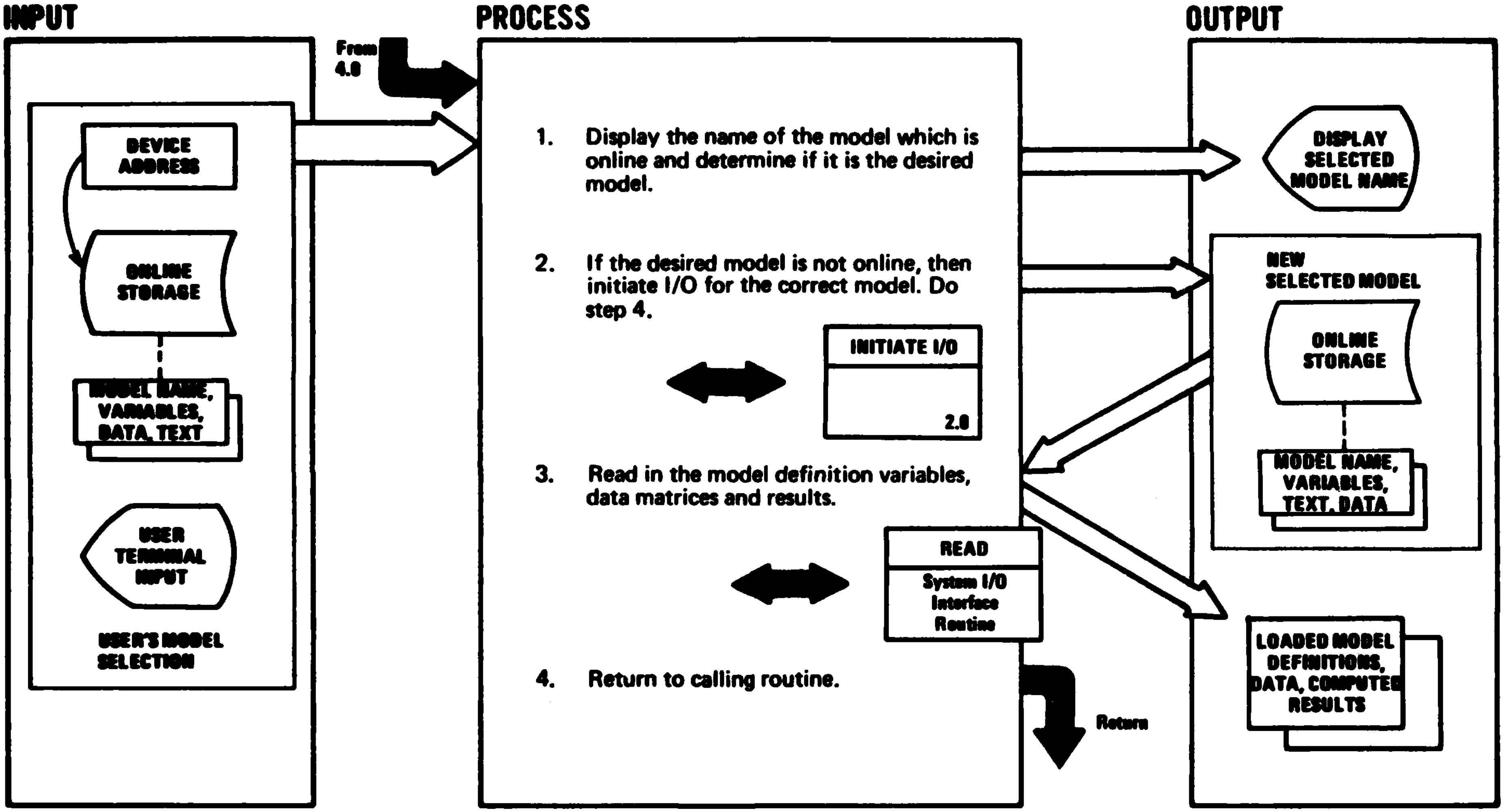
Extended Description

1. Display the options to Load or Save a model in MENU format so that the user may select a process numerically.

2. If the user inputs a blank response, then do step 5.

System/Program: BUILDRAM Name: ____________

Diagram ID: 4.1 Description Load a Model Page: ____ of ____


INPUT
PROCESS
OUTPUT
DEVICE ADDRESS
ONLINE STORAGE
MODEL NAME, VARIABLES, DATA, TEXT
USER TERMINAL INPUT
USER'S MODEL SELECTION
From 4.0
INITIATE I/O
2.0
READ
System I/O Interface Routine
Return
DISPLAY SELECTED MODEL NAME
NEW SELECTED MODEL
ONLINE STORAGE
MODEL NAME, VARIABLES, TEXT, DATA
LOADED MODEL DEFINITIONS, DATA, COMPUTED RESULTS

1. Display the name of the model which is online and determine if it is the desired model.

2. If the desired model is not online, then initiate I/O for the correct model. Do step 4.

3. Read in the model definition variables, data matrices and results.

4. Return to calling routine.

Extended Description

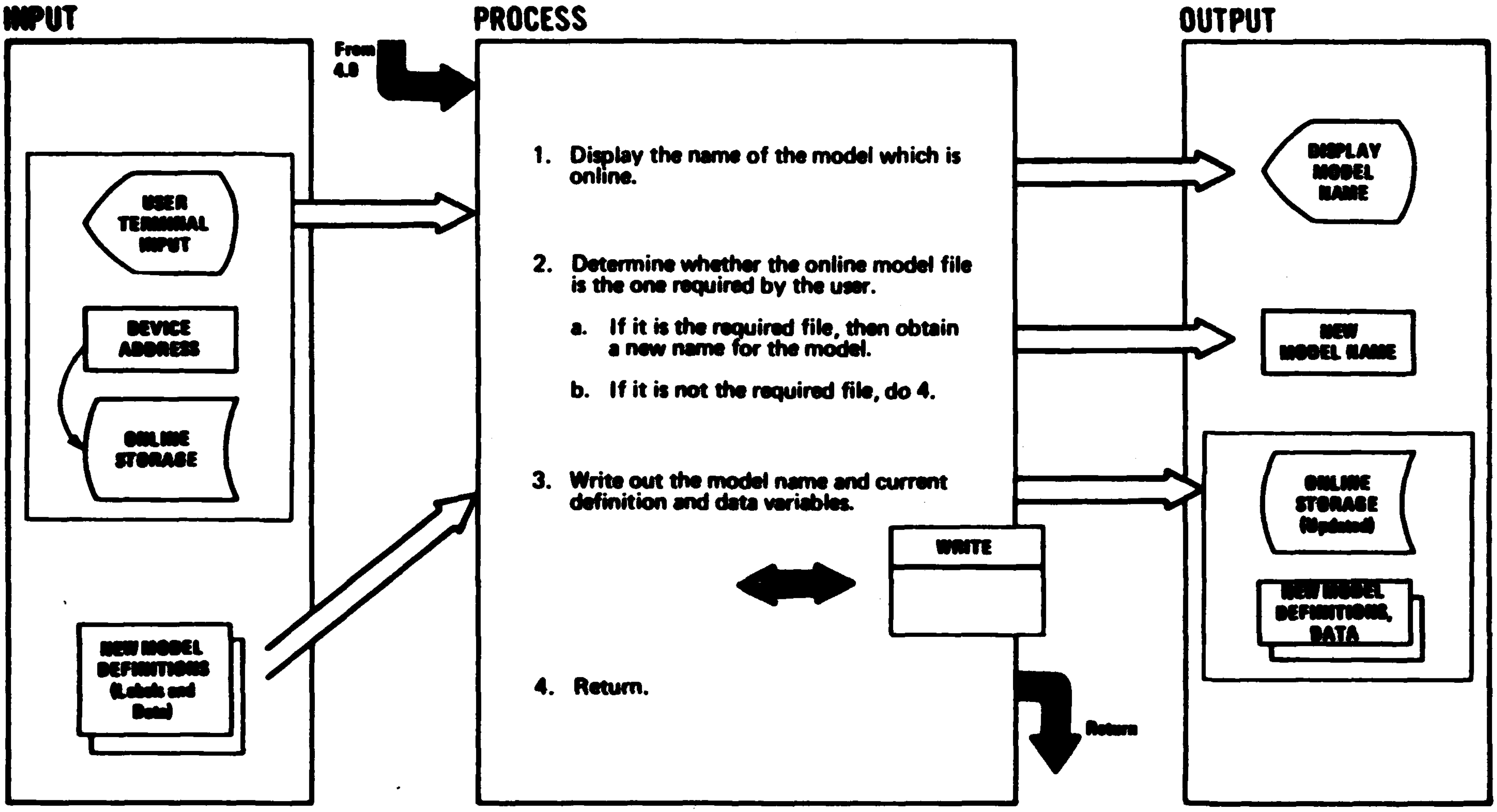
1. The user has the option of switching the online device/file at this time, since only one RAM model is stored per device/file.

2. If the desired device is not already online, then the appropriate one must be placed online and opened for input (see diagram 2.0). An input buffer is created for the newly selected model.

3. Read data commands are issued for the required model definition and data variables. This is accomplished according to an encoded variable list and in the same order as the data items are stored.

System Program: BUILDRAM Name:

Diagram ID: 4.2 Description Save a Model Page: of



1. Display the name of the model which is online.

2. Determine whether the online model file is the one required by the user.

   a. If it is the required file, then obtain a new name for the model.

   b. If it is not the required file, do 4.

3. Write out the model name and current definition and data variables.

4. Return.

Extended Description

1. While the user is operating the RAM program, a file that contains a RAM model should always be online and opened for I/O by the INITIATE routine (see diagram 2.0). The model name is among the stored variables which were read in at "LOAD A MODEL" time (see diagram 4.1).

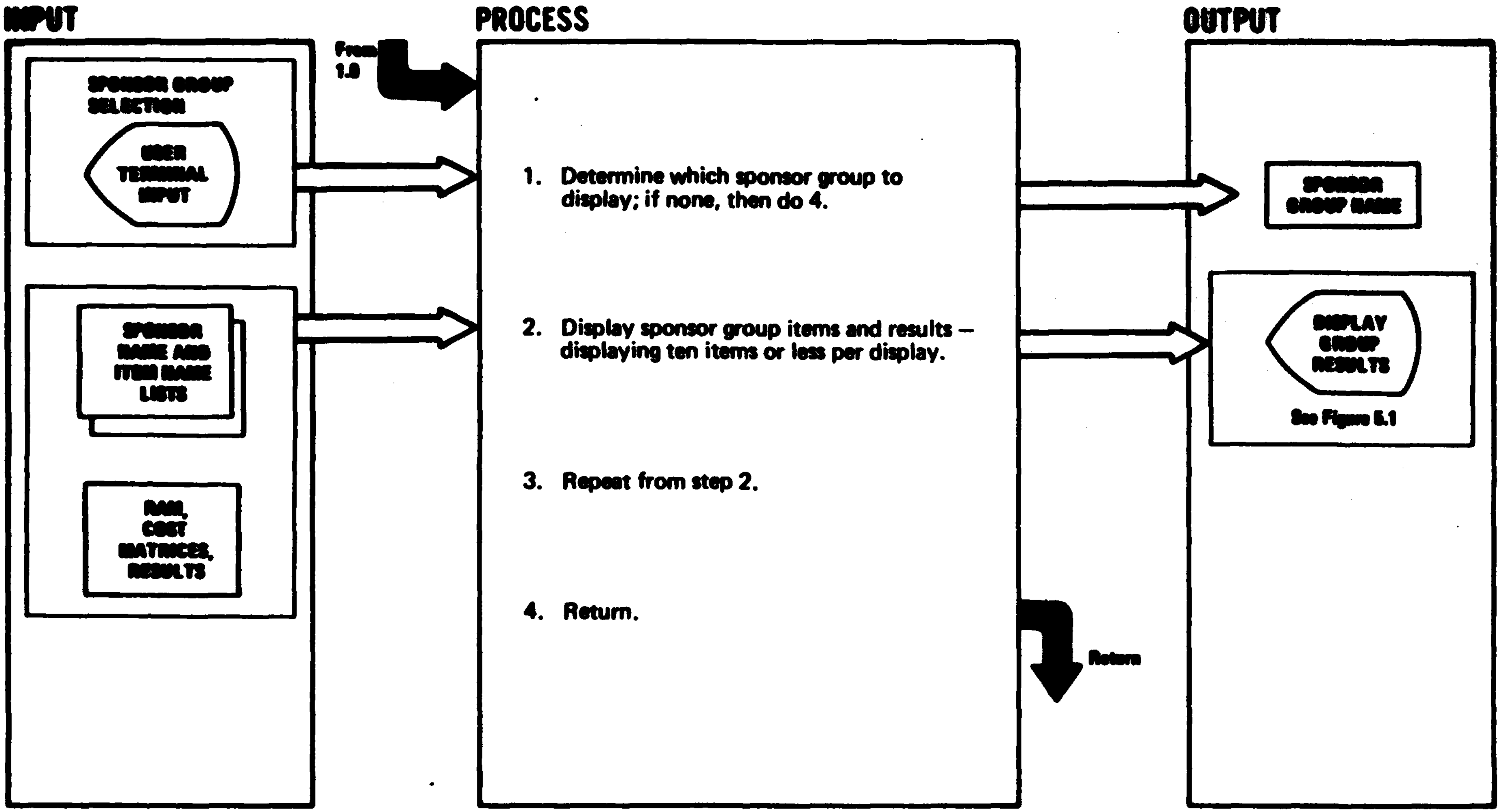
2. The user may indicate after prompting that he does not want to save a model on the currently available file: the routine allows him to return to the main calling routine. If the user wants to store on the available file, he enters a new model name for the file.

3. Write commands are issued causing the model definition variables to be stored in an exact order. The following variables are stored:

1) model name
2) sponsor labels and item labels
3) encoded sponsor-item numbers (the identifiers)
4) a vector of the associated sponsor number per item
5) cross-sponsor weights
6) RAM matrix of benefits and computed results
7) sum of overall benefits per sponsor
8) COST matrix of cost values per item
9) cost-component labels
10) the rank order of cost/benefit values

System Program: BUILDRAM Name:

Diagram ID: 5.0 Description Display Results by Sponsor Page: ___ of ___



1. Determine which sponsor group to display; if none, then do 4.

2. Display sponsor group items and results – displaying ten items or less per display.

3. Repeat from step 2.

4. Return.

Extended Description

1. The user inputs the name of the sponsor group to be displayed or inputs a blank line to terminate this process.

2. Cost-benefit values from the RAM matrix as well as the cost-benefit ratio and rank order of the C/B ratio are displayed beside each item name which was created under the particular sponsor group. The sponsor group name and sum of the overall benefit values for the sponsor are displayed as headings (see figure 5.1).

The RAM matrix contains a set of cost-benefit values for each sponsor item. These values are the following (see figure 5.2):

1) The input benefit value
2) The overall benefit value. This value was computed using cross-sponsor weights (see diagram 10.0)
3) The total cost value computed from the five component cost values
4) The cost-benefit ratio

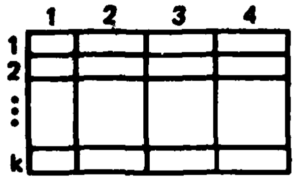
```
               PLNG & INST RESEARCH RAM
            ITEM           SPONSOR  OVERALL    COST   C/B   RANK
                           BENEFIT  BENEFIT
1  2)ALUMNI SURVEY           25.0      2.5      5.0    2.0     3
1  3)ARCHITECTURAL SURVEY   100.0     10.0     80.0    8.0    17
1  4)EXPANSION PLANNING      65.0      6.5    113.0   17.4    21
1  1)SECRETARIAL SERVICES    10.0      1.0     95.0   95.0    24

PLEASE RETURN CARRIAGE TO CONTINUE
```

HIPO Figure 5.1

DISPLAY OF SPONSOR RESULTS

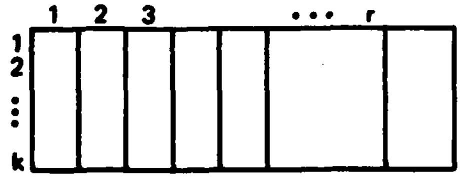
RAM AND COST MATRICES

RAM matrix – Number of Items = k



Columns No. 1: Benefit value specified by the user
No. 2: Over-all benefit value
No. 3: Total cost across cost components
No. 4: Cost-benefit ratio

COST matrix – Number of items = k
– Number cost components = r

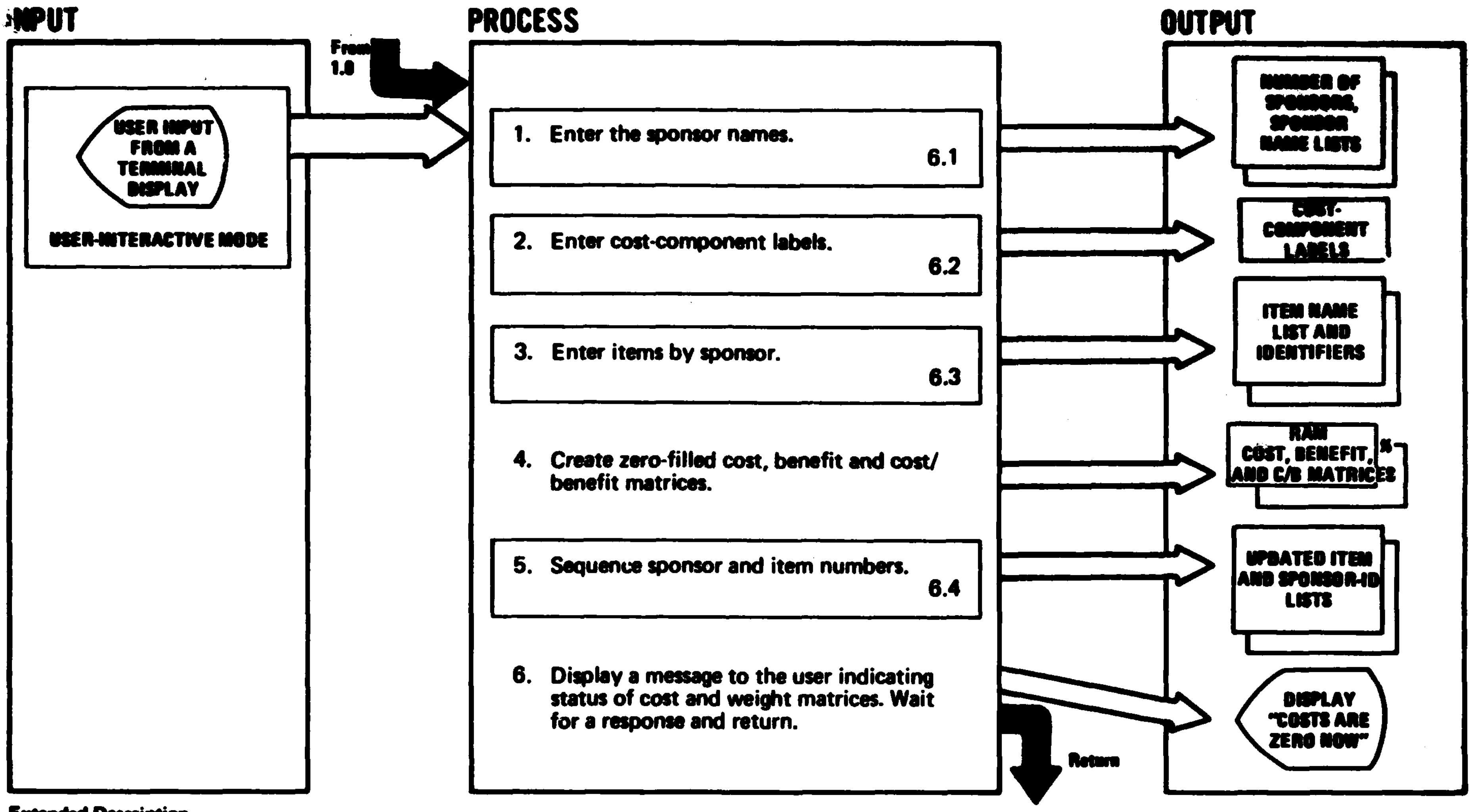


Columns No. 1 through r = costs for each of the r components (usually r = 5)
No. r + 1 : "other" costs single value

HIPO Figure 5.2
STRUCTURE OF THE RAM AND COST MATRICES

System/Program: BUILDRAM Name:

Diagram ID: 6.0 Description Create a Model Structure Page: of


INPUT
USER INPUT FROM A TERMINAL DISPLAY
USER-INTERACTIVE MODE
From 1.0
PROCESS
OUTPUT
NUMBER OF SPONSORS, SPONSOR NAME LISTS
COST-COMPONENT LABELS
ITEM NAME LIST AND IDENTIFIERS
RAW COST, BENEFIT, AND C/B MATRICES
UPDATED ITEM AND SPONSOR-ID LISTS
DISPLAY "COSTS ARE ZERO NOW"
Return

1. Enter the sponsor names. 6.1

2. Enter cost-component labels. 6.2

3. Enter items by sponsor. 6.3

4. Create zero-filled cost, benefit and cost/benefit matrices.

5. Sequence sponsor and item numbers. 6.4

6. Display a message to the user indicating status of cost and weight matrices. Wait for a response and return.

Extended Description

To create a model structure, certain variable lists and data matrices must be formed. These same variables may be stored after creation in order to preserve the model definitions.

1–3. The creation of sponsor name and item lists and identifiers as well as the creation of cost-component and labels for output are explained in detail in diagrams 6.1–6.3.

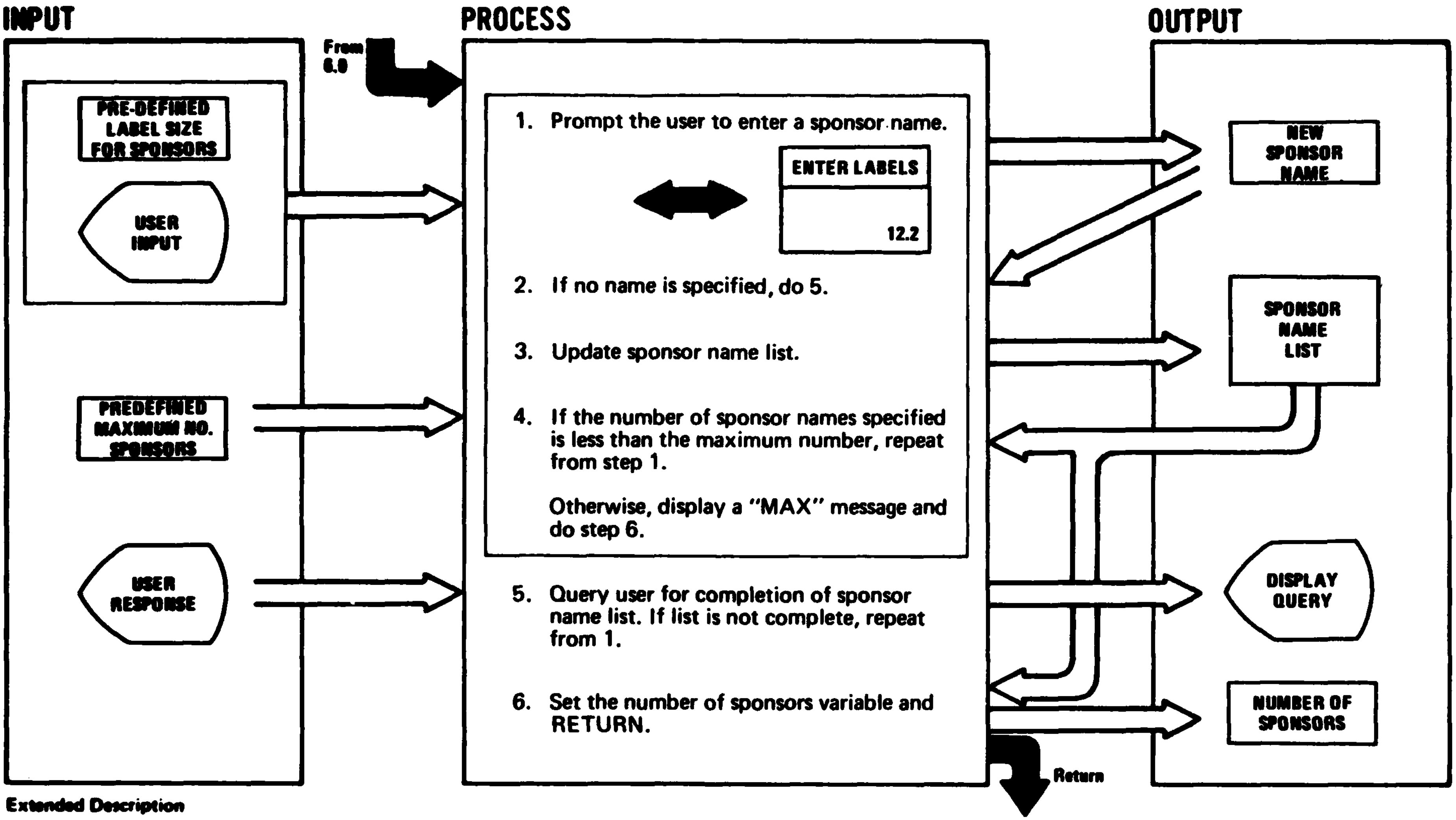
4. Arrays of the correct length and size are created for later cost-benefit ratio and cross-weighting computations. Cost and benefit arrays must have the same number of rows as the total number of cost items which were entered in step 3.

5. Sponsor cost items may be entered at step 3 in a different order from the input of sponsor names at step 1; therefore, the numerical identifiers must be sorted for compatibility.

6. Display a message to remind the user that cost and benefit values are now zero and should be updated.

System/Program: BUILDRAM Name: ______

Diagram ID: 6.1 Description Enter Sponsor Names Page: ____ of ____



1. Prompt the user to enter a sponsor name.

2. If no name is specified, do 5.

3. Update sponsor name list.

4. If the number of sponsor names specified is less than the maximum number, repeat from step 1.

   Otherwise, display a "MAX" message and do step 6.

5. Query user for completion of sponsor name list. If list is not complete, repeat from 1.

6. Set the number of sponsors variable and RETURN.

Extended Description

1. Labels for the sponsor groups are entered directly from the keyboard by the user. The number of characters allowed per name label is predefined and therefore constant.

Diagram 12.2 describes the process by which a label is entered and returned.

2. If no name is specified by the user, a blank or zero is returned from the labels subroutine, the entering of labels process ends.

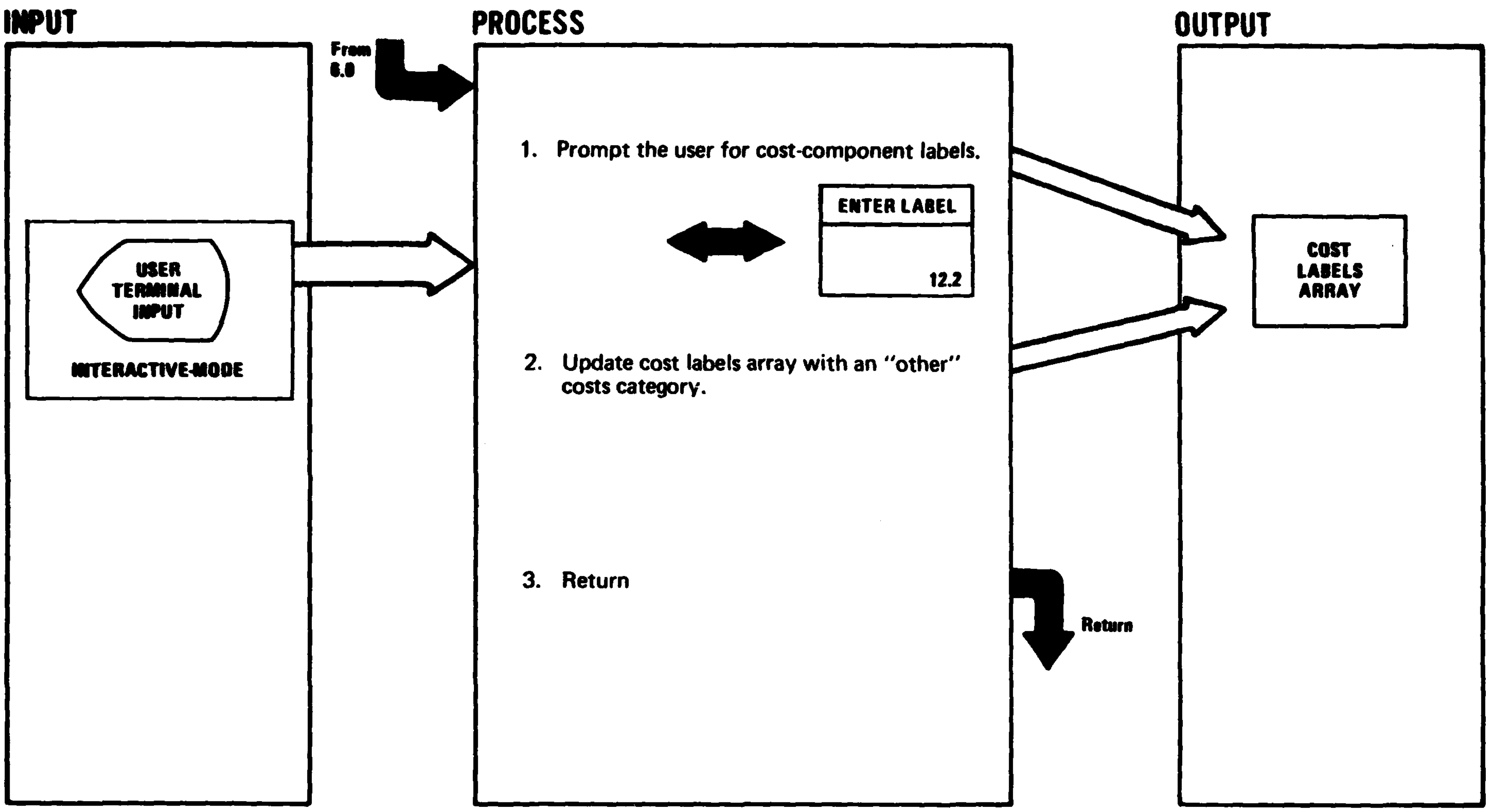
3. The sponsor name list is a contiguous array created and updated in this function. If the name entered in step 2 is the first name, the list is created; otherwise, the list is updated.

4. A pre-determined maximum for the number of sponsors is used in this step.

5. Normally, steps 1–4 are repeated until the user fails to enter a non-blank label. At this point a query prompts the user for completion of list.

System/Program: BUILDRAM Name: ________

Diagram ID: 6.2 Description Enter Cost-Component Labels Page: ____ of ____



1. Prompt the user for cost-component labels.

2. Update cost labels array with an "other" costs category.

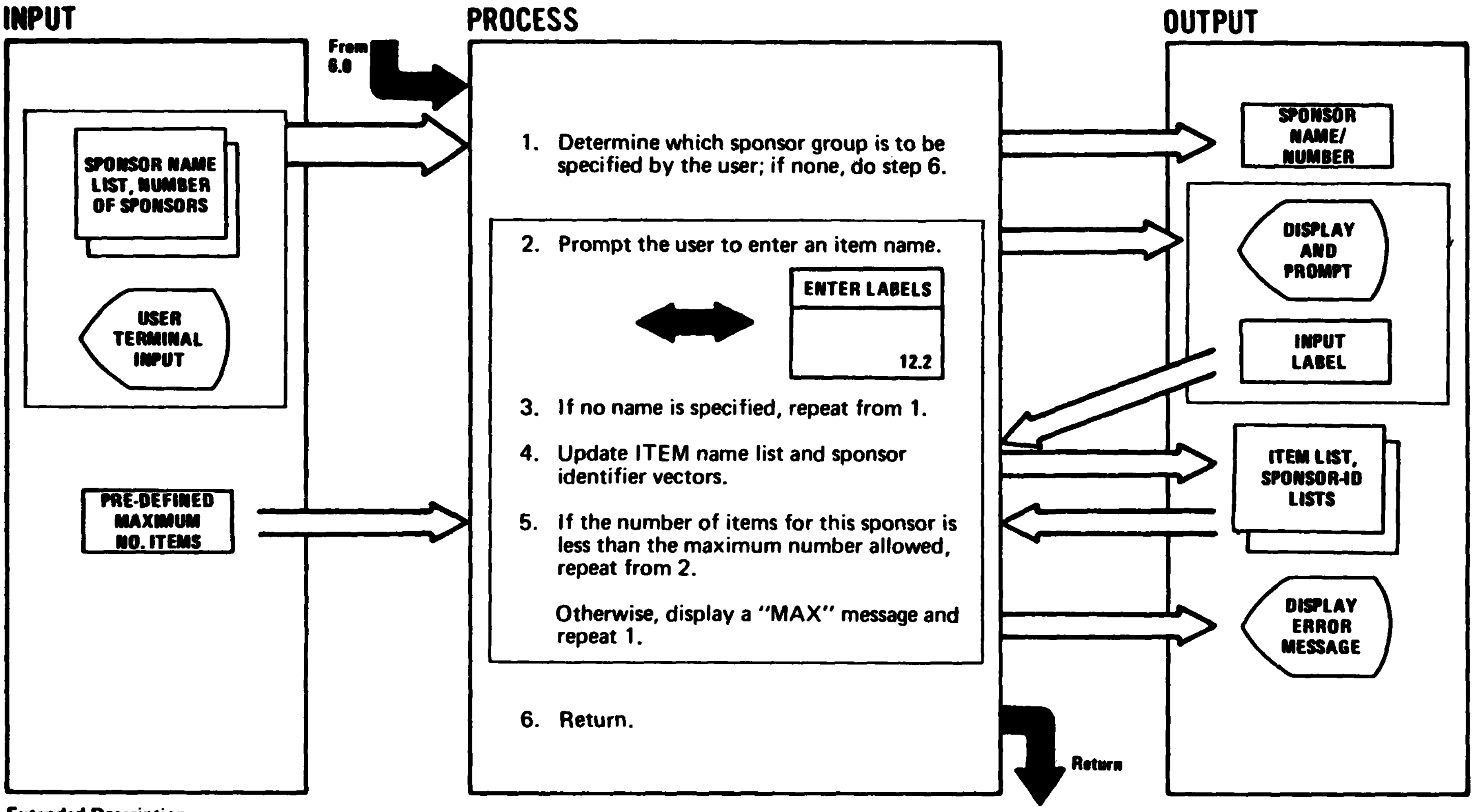
3. Return

Extended Description

2. The labels entered in step 1 are stored in the cost-labels array. Also, the label "other" for other costs is added to the array.

System/Program: BUILDRAM Name:

Diagram ID: 6.3 Description Enter Items by Sponsor Page: of



1. Determine which sponsor group is to be specified by the user; if none, do step 6.

2. Prompt the user to enter an item name.

3. If no name is specified, repeat from 1.

4. Update ITEM name list and sponsor identifier vectors.

5. If the number of items for this sponsor is less than the maximum number allowed, repeat from 2.

   Otherwise, display a "MAX" message and repeat 1.

6. Return.

Extended Description

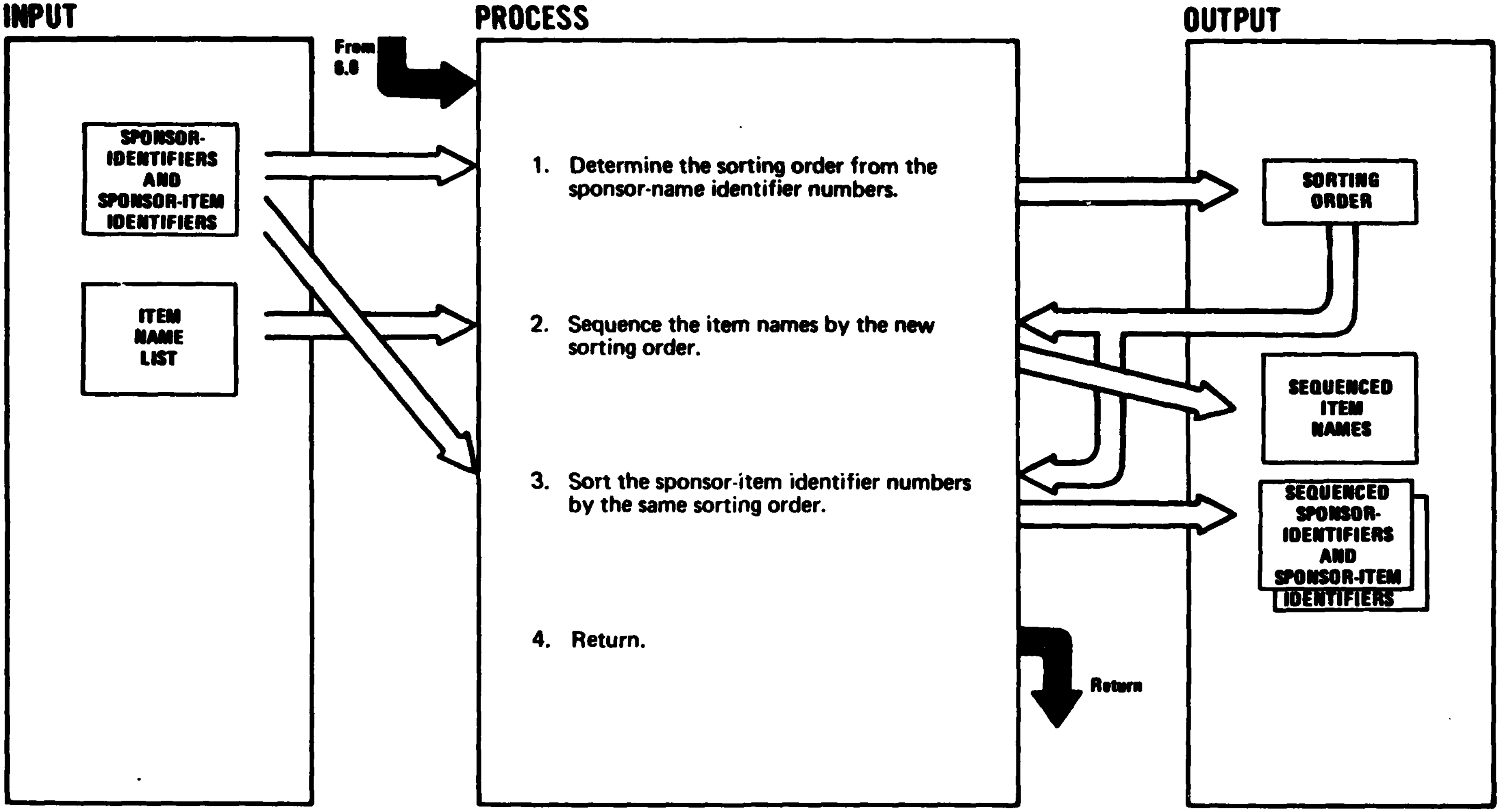
1. Prompt the user for the name or the index number of the sponsor group for the next set of items to be entered. This is done so that the user may start specifying items for particular sponsors in any desired order.

4. On first time through, the item list and sponsor-identifier number (for each item) vectors are created. As new item labels are entered, the item name list is expanded, the associated sponsor group number is added to the identifier vector, and an encoded sponsor-item number is added to the sponsor-item identifier list.

The sponsor-item identifier numbers will be used in the program to determine index locations in cost/benefit matrices and for display purposes.

System/Program: BUILDRAM Name:

Diagram ID: 6.4 Description Sequence Sponsors and Items Page: of


INPUT
PROCESS
OUTPUT
From 6.0
SPONSOR-IDENTIFIERS AND SPONSOR-ITEM IDENTIFIERS
ITEM NAME LIST
SORTING ORDER
SEQUENCED ITEM NAMES
SEQUENCED SPONSOR-IDENTIFIERS AND SPONSOR-ITEM IDENTIFIERS
Return

1. Determine the sorting order from the sponsor-name identifier numbers.

2. Sequence the item names by the new sorting order.

3. Sort the sponsor-item identifier numbers by the same sorting order.

4. Return.

Extended Description

1. Compute the index values for sponsor identifiers of increasing numerical order and save these values as the new sorting order.

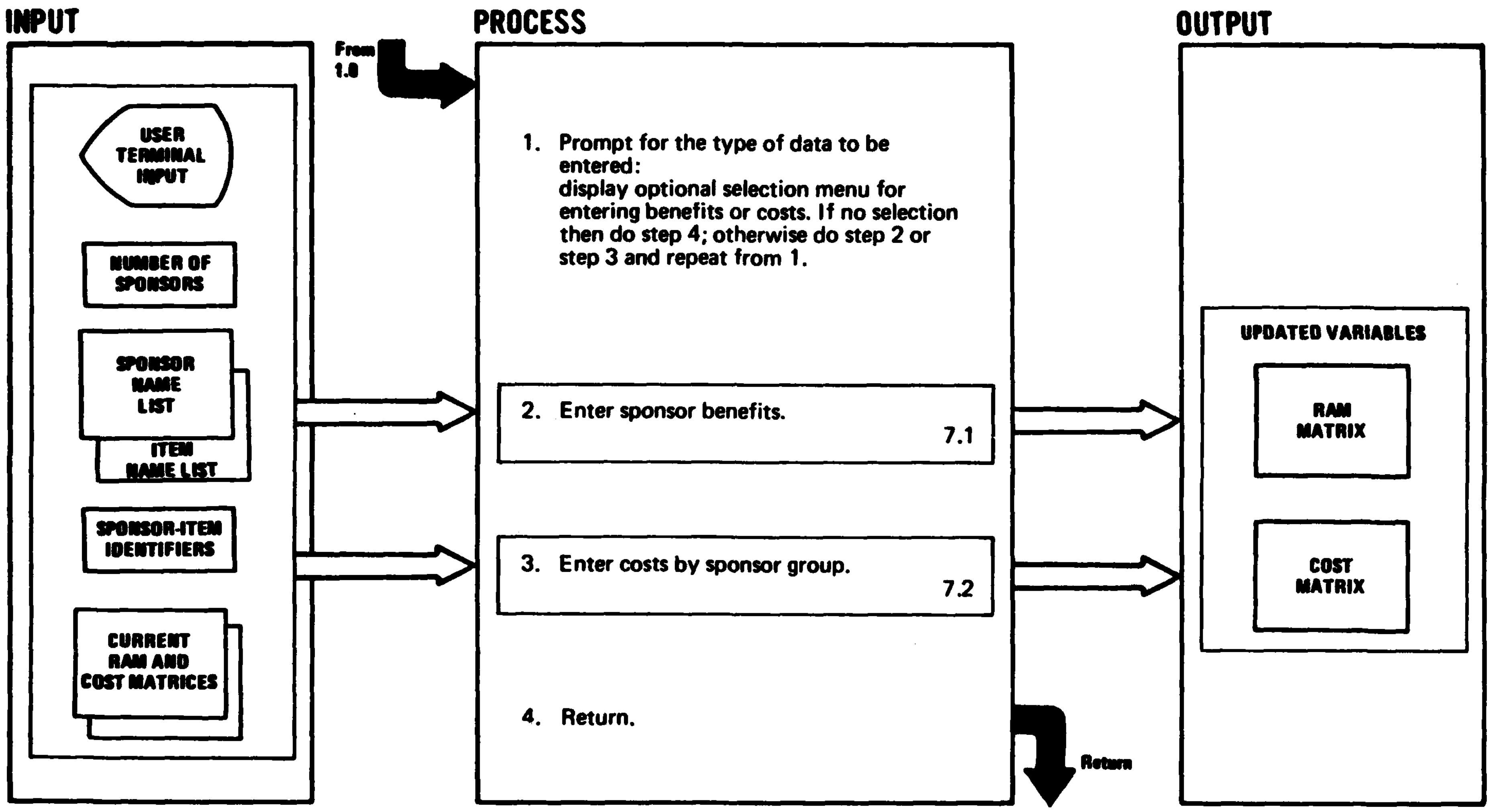
2. Rearrange the cost item names by the new sorting order of index values. Replace the old item list with the new sequenced list.

3. Rearrange the sponsor identifier number for each item by the new sorting order index values. Replace the old identifier list. Rearrange the sponsor-item encoded list also.

Note that the sponsor-identifiers vector contains an element for each item in the new sequence order of items: each element is the index value of the sponsor name in the sponsor name list.

System/Program: BUILDRAM Name:

Diagram ID: 7.0 Description Enter Benefits and Costs Page: of



1. Prompt for the type of data to be entered:
   display optional selection menu for entering benefits or costs. If no selection then do step 4; otherwise do step 2 or step 3 and repeat from 1.
2. Enter sponsor benefits. 7.1
3. Enter costs by sponsor group. 7.2
4. Return.

Extended Description

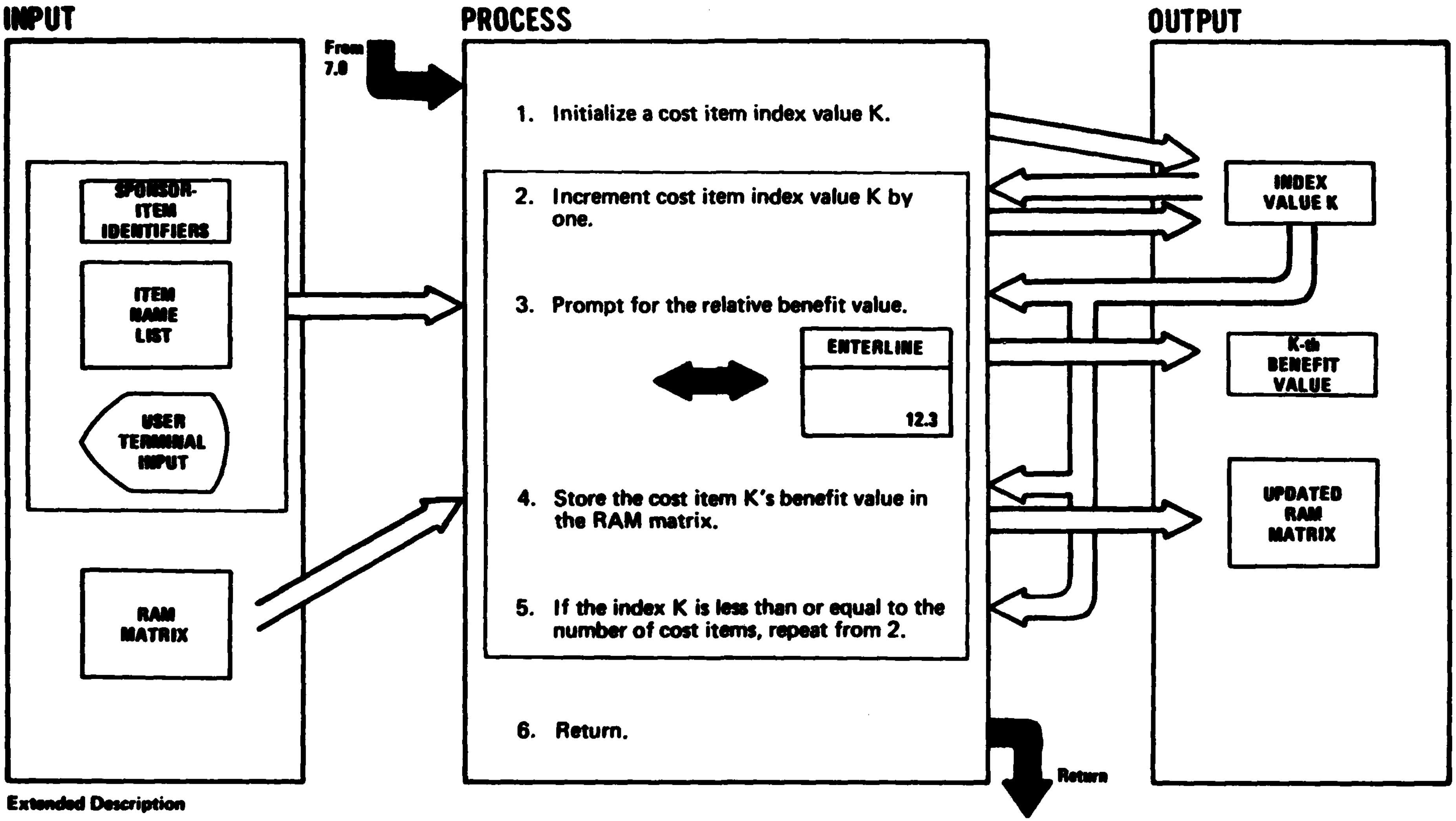
This routine is called when the user selects the option to enter data from the main options menu.

RAM (cost-benefit) matrix and the COST components matrix are created prior to the calling of this routine.

For the detail descriptions of sub-processes 2 and 3, see diagrams 7.1 and 7.2.

System/Program: BUILDRAM Name:

Diagram ID: 7.1 Description Enter Sponsor Benefits Page: of



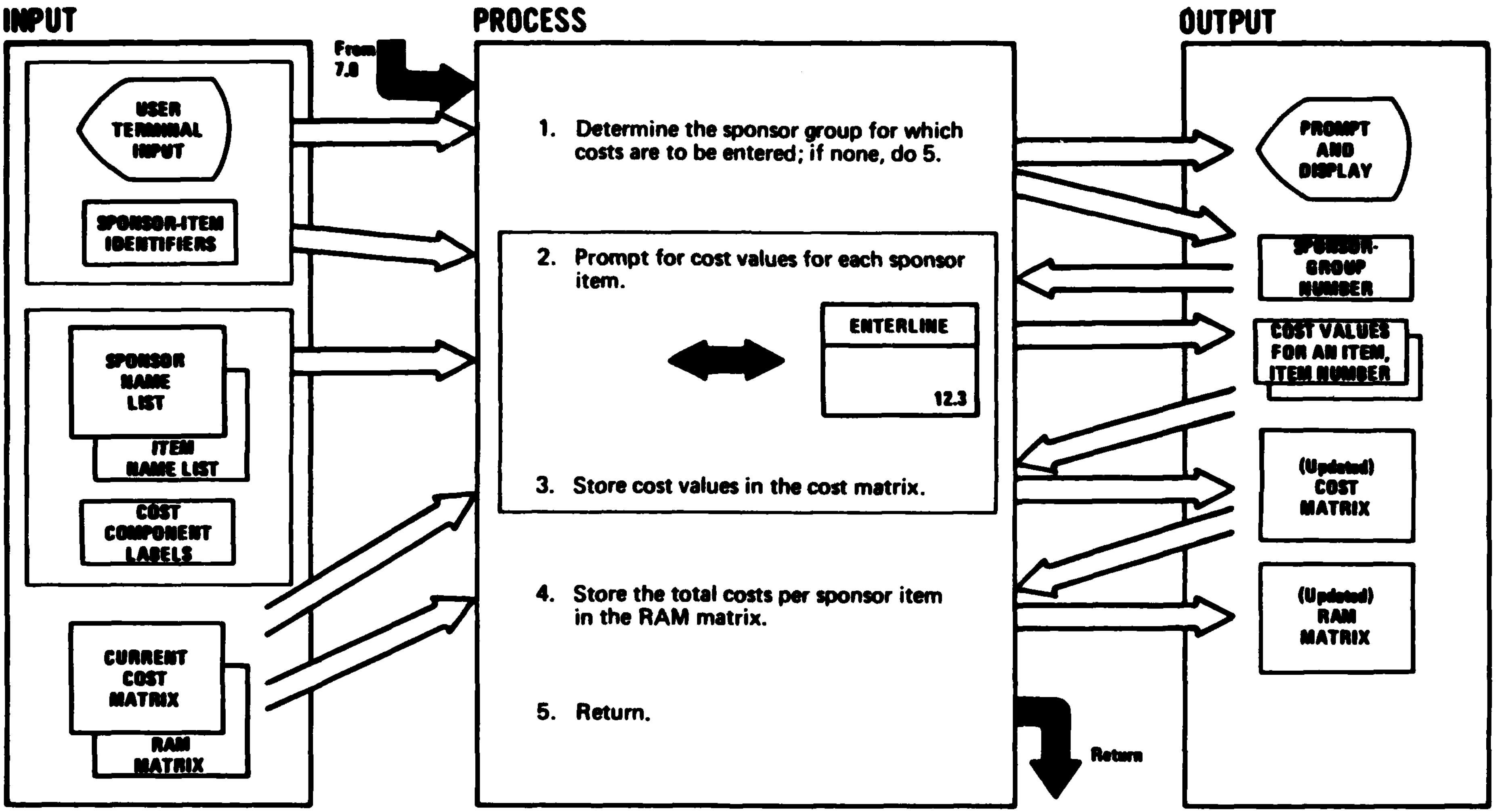
1. Initialize a cost item index value K.
2. Increment cost item index value K by one.
3. Prompt for the relative benefit value.
4. Store the cost item K's benefit value in the RAM matrix.
5. If the index K is less than or equal to the number of cost items, repeat from 2.
6. Return.

Extended Description

1. An index value is initialized so that it may be used to display the appropriate item names and list identifier numbers in step 3 and to update the associated benefit value in the RAM matrix (step 4.)

System/Program: BUILDRAM Name: ____________

Diagram ID: 7.2 Description Enter Costs by Sponsor Group Page: ____ of ____



INPUT

PROCESS

OUTPUT

From 7.0

1. Determine the sponsor group for which costs are to be entered; if none, do 5.

2. Prompt for cost values for each sponsor item.

3. Store cost values in the cost matrix.

4. Store the total costs per sponsor item in the RAM matrix.

5. Return.

Extended Description

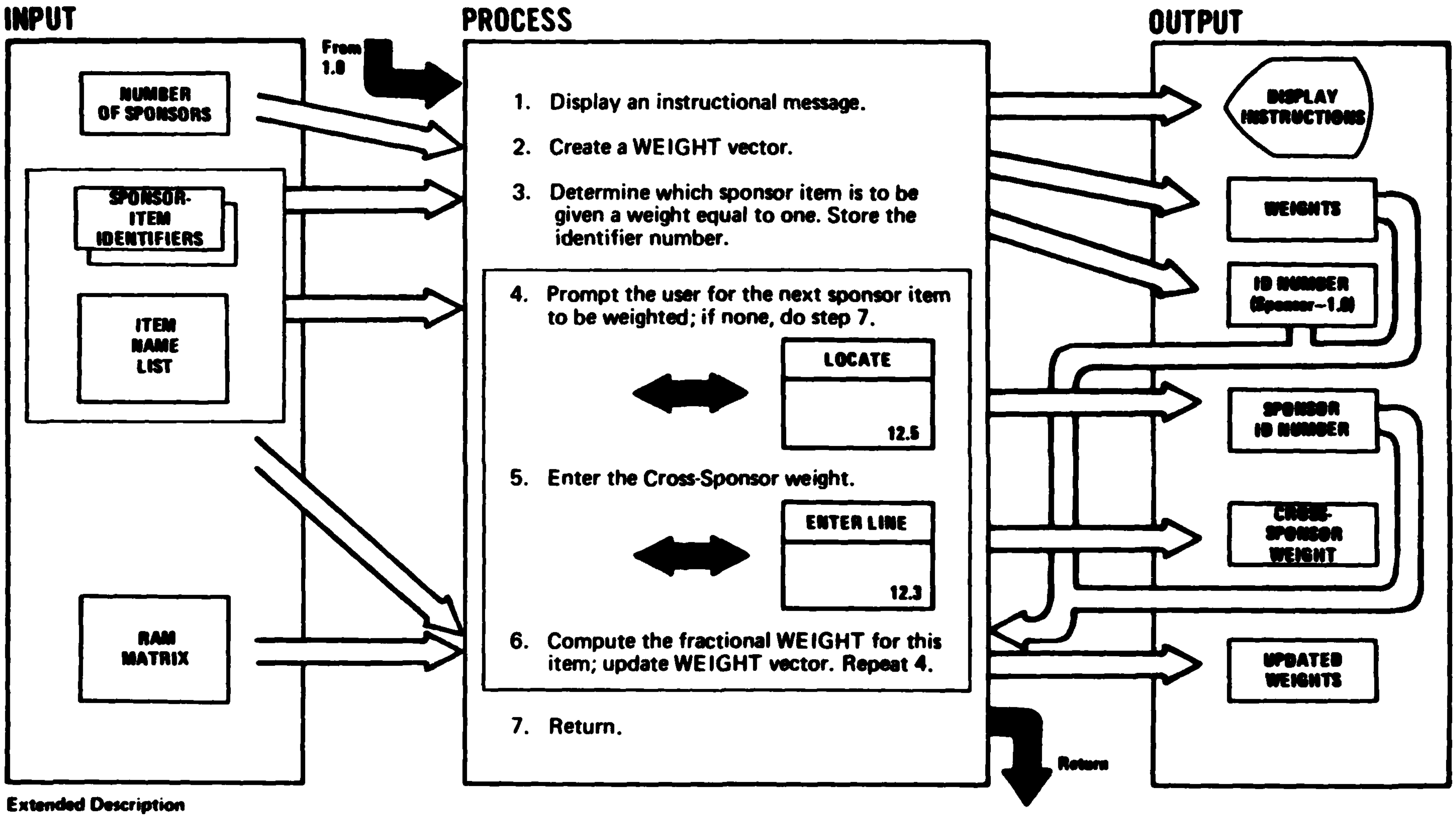
1. Prompt and obtain from the user the next group for which cost values are to be entered.

2 – 3. For the selected group, prompt the user for cost values for each cost component per item. Repeat for each item within the selected sponsor group.

4. Compute the total cost over the components for each item and store in the RAM matrix.

System/Program: BUILDRAM Name:

Diagram ID: 8.0 Description Develop Cross-Sponsor Weights Page: of



1. Display an instructional message.

2. Create a WEIGHT vector.

3. Determine which sponsor item is to be given a weight equal to one. Store the identifier number.

4. Prompt the user for the next sponsor item to be weighted; if none, do step 7.

5. Enter the Cross-Sponsor weight.

6. Compute the fractional WEIGHT for this item; update WEIGHT vector. Repeat 4.

7. Return.

Extended Description

1. A brief description of the manner in which cross-sponsor weights are to be entered by the user is displayed.

2. A weight vector is created with the number of elements equal to the number of sponsors. The initial value of all vector elements is one.

3. The user is prompted for the identifier numbers of the most significant sponsor item. The most significant sponsor cost item will be given a weight = 1. All other significant items in a different sponsor group will be weighted relative to this item.

Steps 4–6 are repeated until a cross-sponsor weight has been specified for each sponsor group.

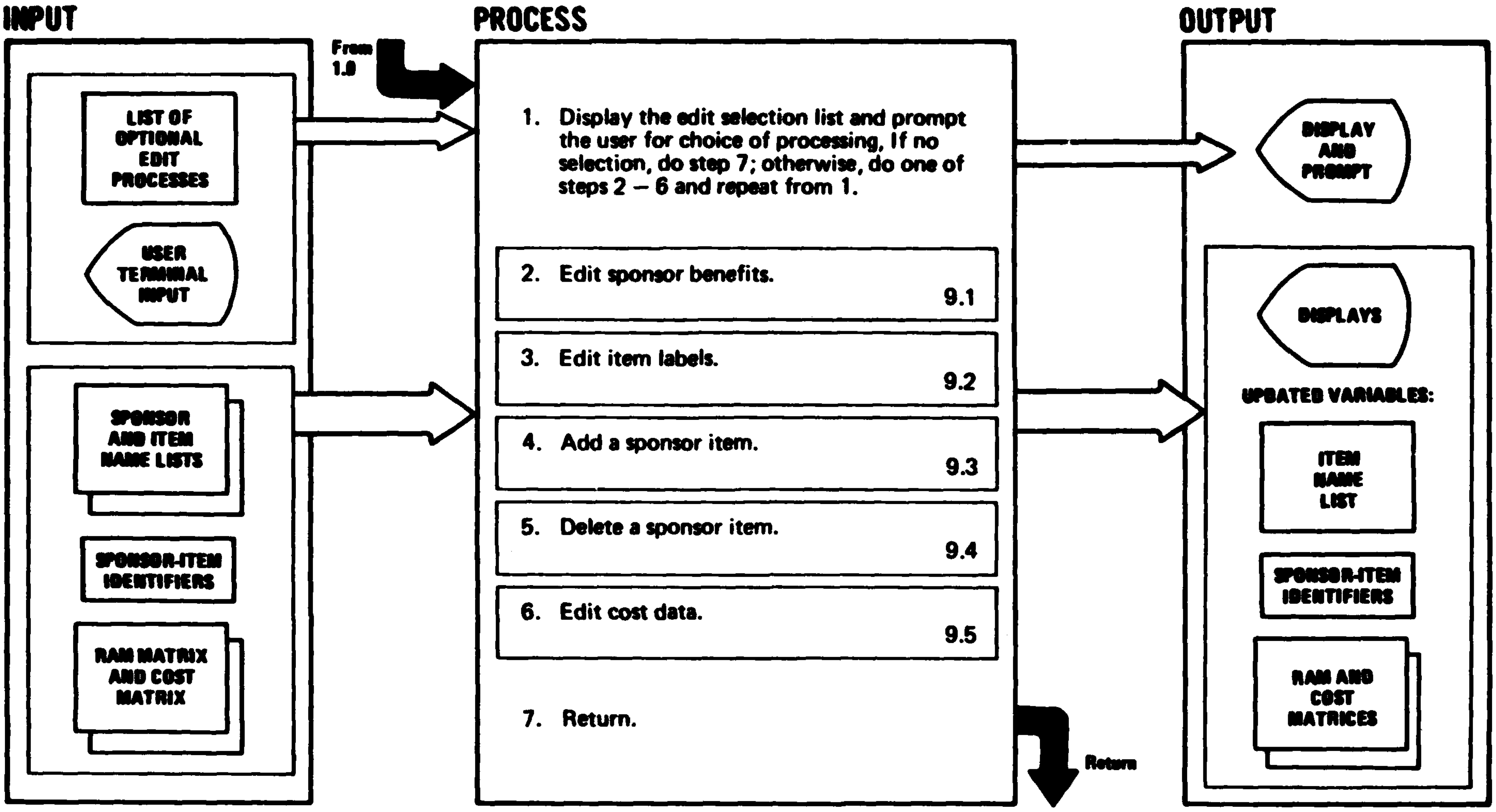
4. Call subroutine LOCATE (see diagram 12.5) to get the next sponsor item to be weighted.

5. Call subroutine ENTERLINE (see diagram 12.3) to obtain the weight value from keyboard input. The value should be less than one and greater than 0.

6. The benefit value (obtained from the RAM matrix) for the most significant item is multiplied by the cross-sponsor weight. This new value is then divided by the benefit value for the item just weighted and the result is stored in the appropriate WEIGHT element for the sponsor group to which the item belongs.

System/Program: BUILDRAM Name:

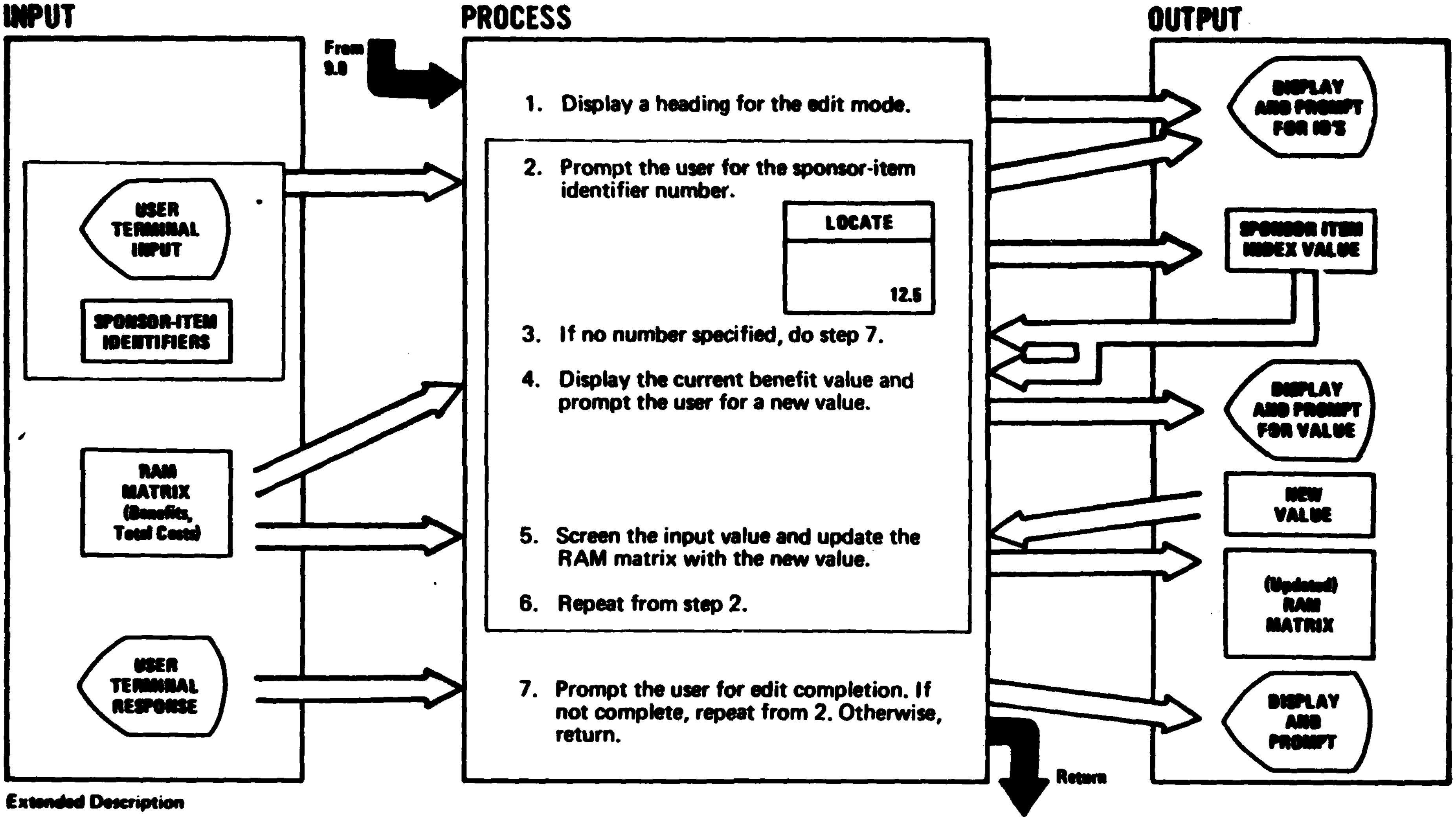
Diagram ID: 9.0 Description Edit the Model Page: of



1. Display the edit selection list and prompt the user for choice of processing, If no selection, do step 7; otherwise, do one of steps 2 – 6 and repeat from 1.
2. Edit sponsor benefits. 9.1
3. Edit item labels. 9.2
4. Add a sponsor item. 9.3
5. Delete a sponsor item. 9.4
6. Edit cost data. 9.5
7. Return.

System/Program: BUILDRAM Name: ________

Diagram ID: 9.1 Description Edit Sponsor Benefits Page: ___ of ___



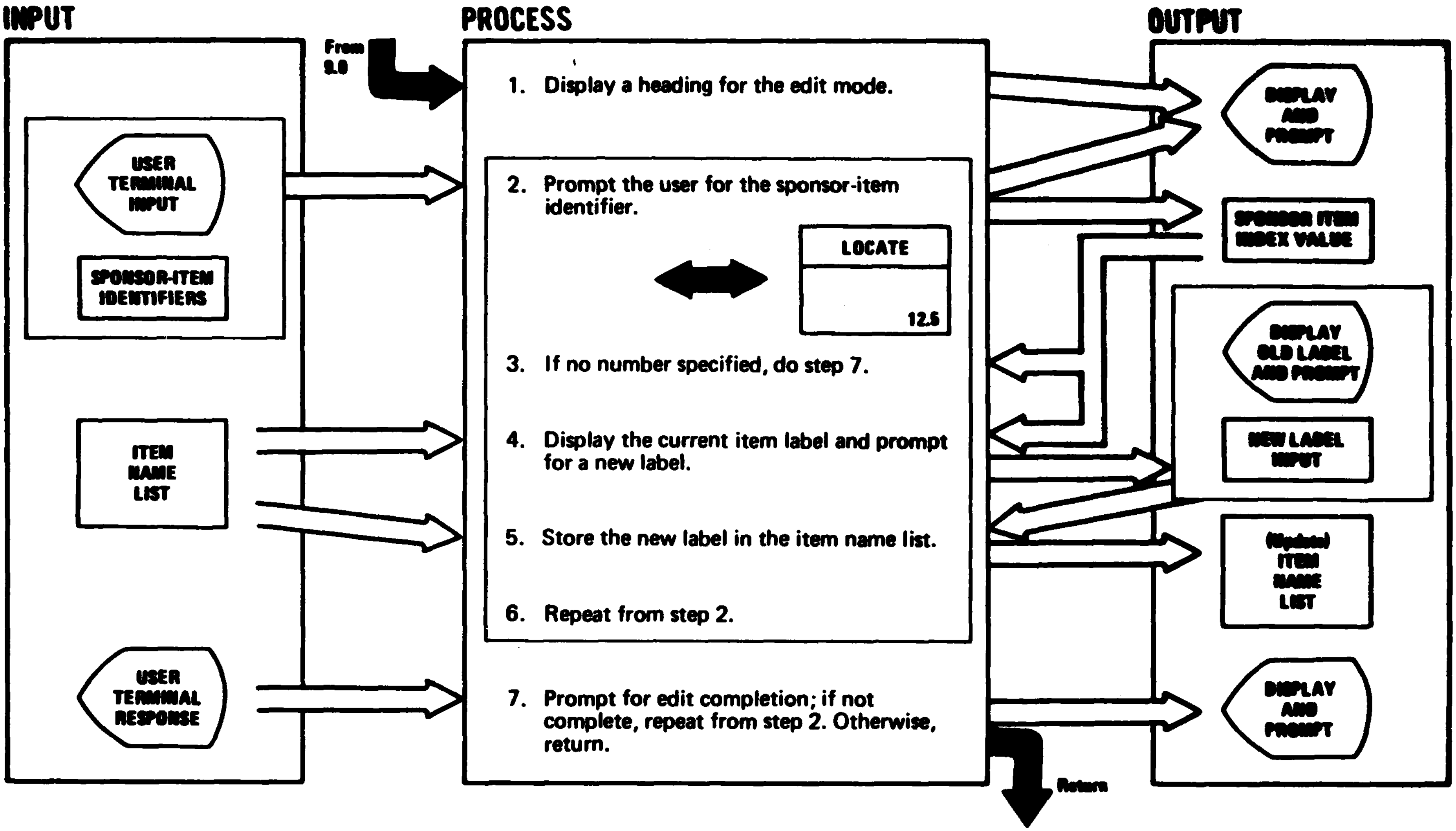
1. Display a heading for the edit mode.
2. Prompt the user for the sponsor-item identifier number.
3. If no number specified, do step 7.
4. Display the current benefit value and prompt the user for a new value.
5. Screen the input value and update the RAM matrix with the new value.
6. Repeat from step 2.
7. Prompt the user for edit completion. If not complete, repeat from 2. Otherwise, return.

Extended Description

5. The new value may be entered directly from keyboard and then converted, tested for validity, and stored. As an alternative, the "ENTERLINE" routine (diagram 12.3) may be used to obtain the new values.

System/Program: BUILDRAM Name:

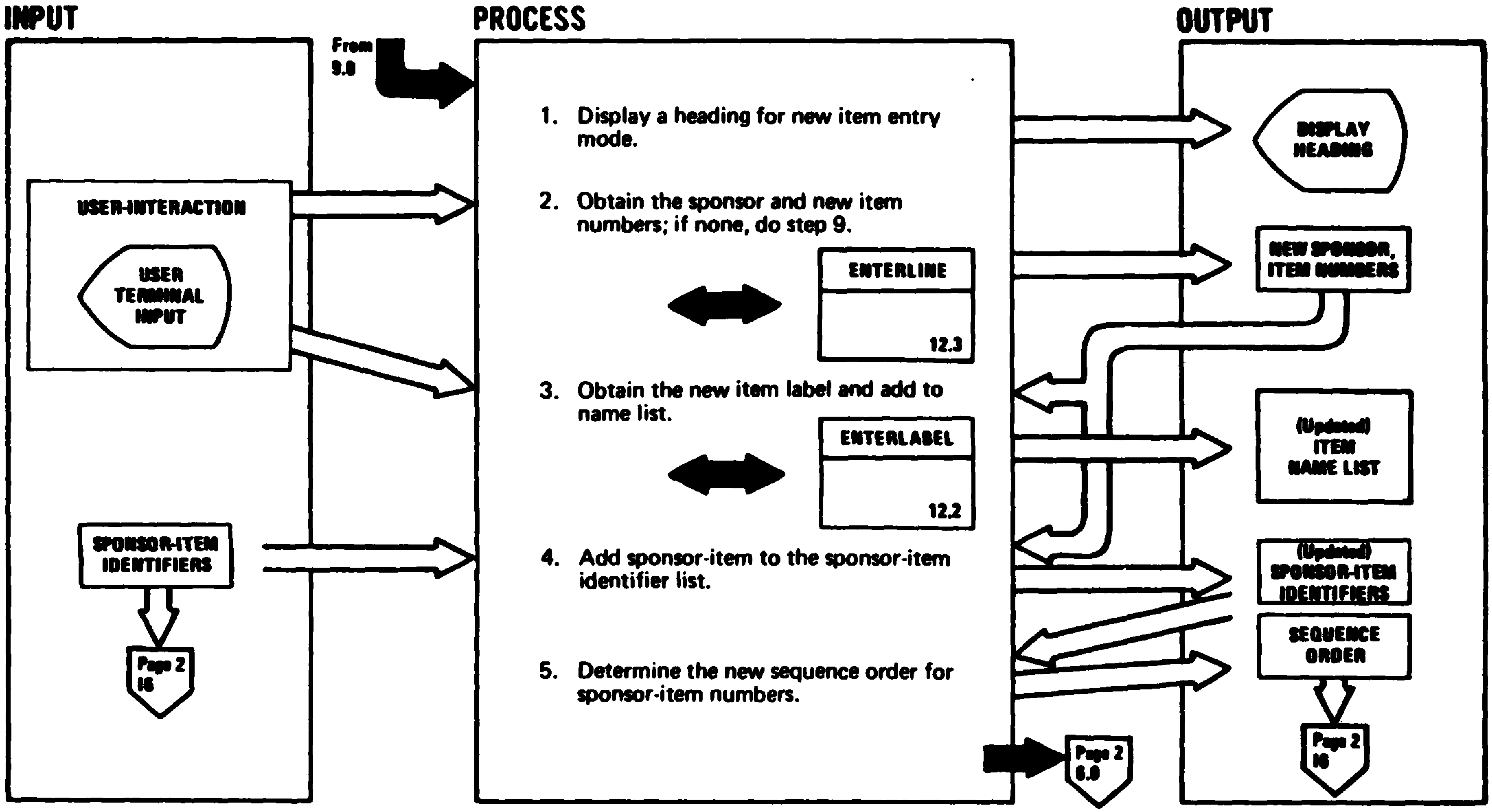
Diagram ID: 9.2 Description Edit Item Labels Page: of



1. Display a heading for the edit mode.
2. Prompt the user for the sponsor-item identifier.
3. If no number specified, do step 7.
4. Display the current item label and prompt for a new label.
5. Store the new label in the item name list.
6. Repeat from step 2.
7. Prompt for edit completion; if not complete, repeat from step 2. Otherwise, return.

System/Program: BUILDRAM Name:

Diagram ID: 9.3 Description Add a Sponsor Item Page: 1 of 2

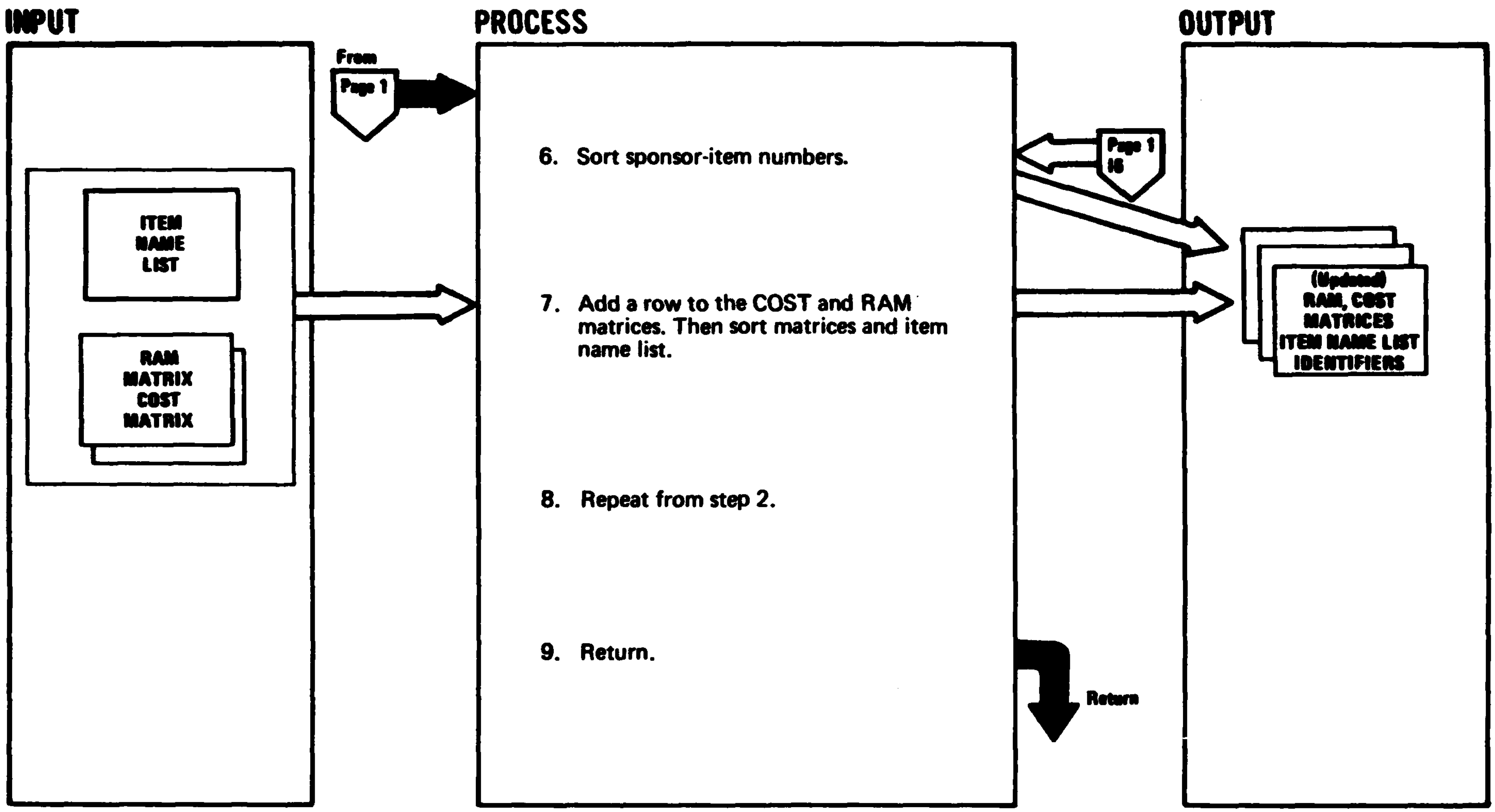


1. Display a heading for new item entry mode.
2. Obtain the sponsor and new item numbers; if none, do step 9.
3. Obtain the new item label and add to name list.
4. Add sponsor-item to the sponsor-item identifier list.
5. Determine the new sequence order for sponsor-item numbers.

Extended Description

System/Program: BUILDRAM Name:

Diagram ID: 9.3 Description Add a Sponsor Item Page: 2 of 2



6. Sort sponsor-item numbers.

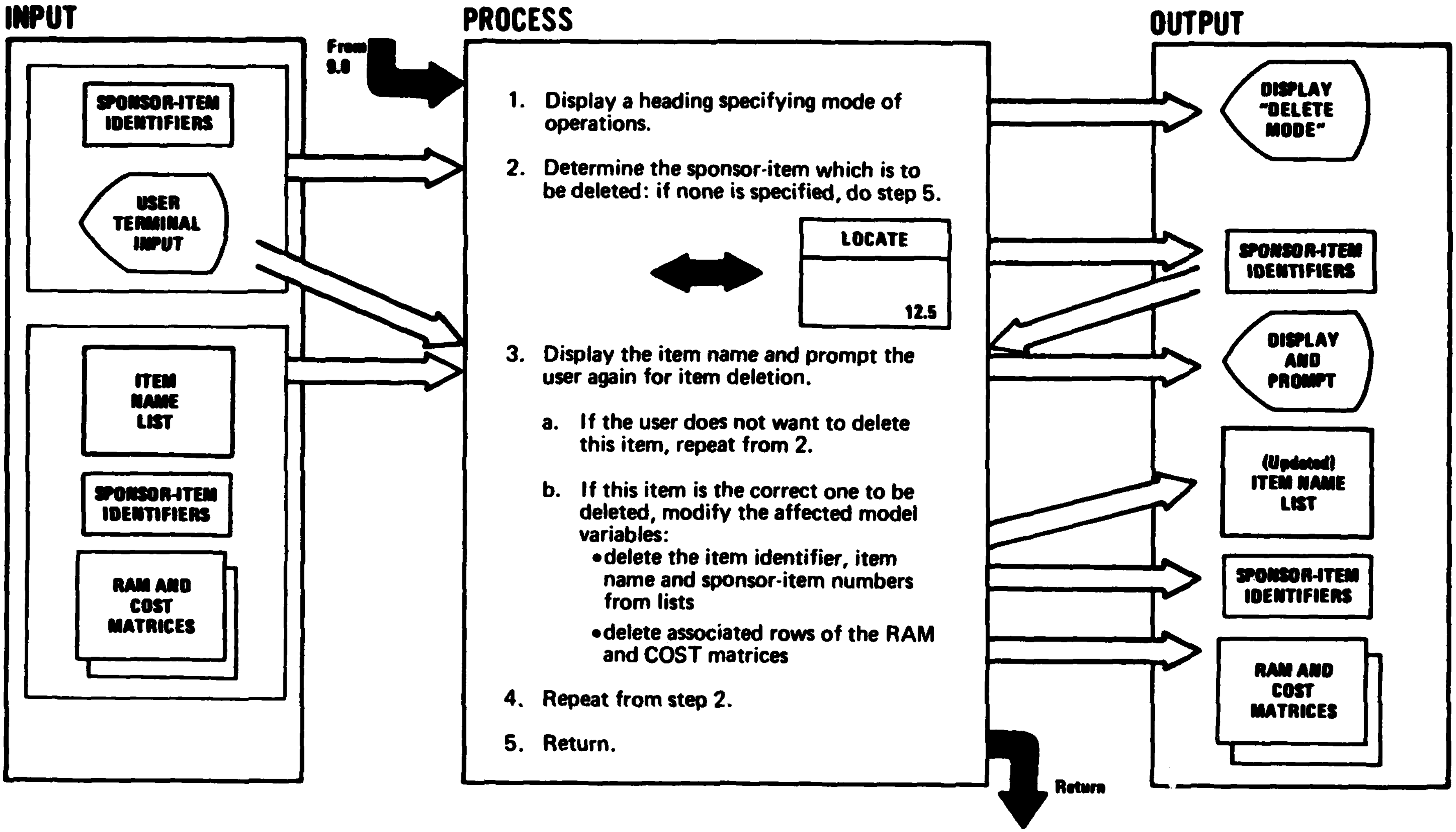
7. Add a row to the COST and RAM matrices. Then sort matrices and item name list.

8. Repeat from step 2.

9. Return.

System/Program: BUILDRAM Name: ________

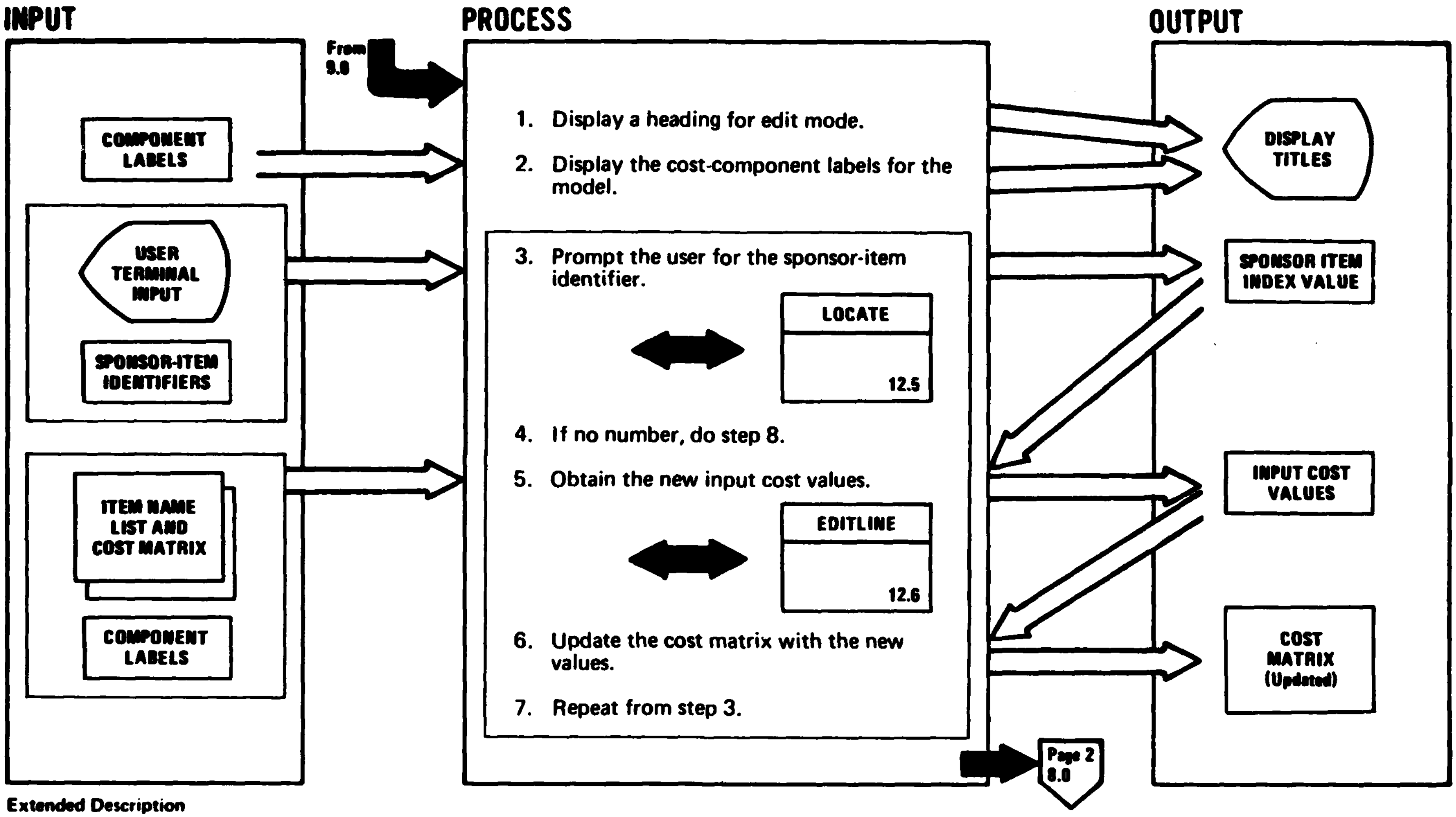
Diagram ID: 9.4 Description Delete a Sponsor Item Page: ____ of ____



1. Display a heading specifying mode of operations.
2. Determine the sponsor-item which is to be deleted: if none is specified, do step 5.
3. Display the item name and prompt the user again for item deletion.
   a. If the user does not want to delete this item, repeat from 2.
   b. If this item is the correct one to be deleted, modify the affected model variables:
      - delete the item identifier, item name and sponsor-item numbers from lists
      - delete associated rows of the RAM and COST matrices
4. Repeat from step 2.
5. Return.

System/Program: BUILDRAM Name:

Diagram ID: 9.5 Description Edit Cost Data Page: 1 of 2



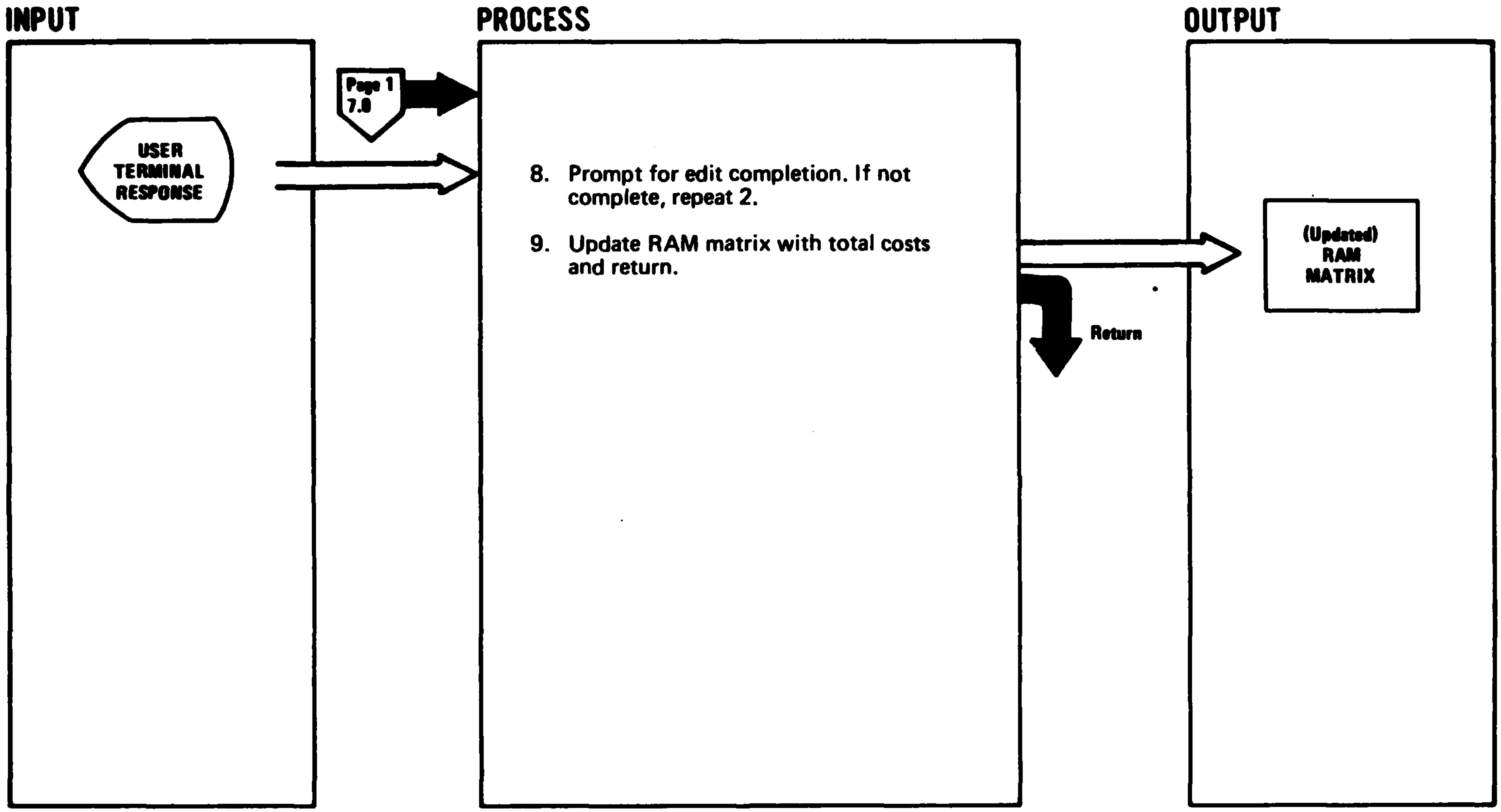
1. Display a heading for edit mode.
2. Display the cost-component labels for the model.
3. Prompt the user for the sponsor-item identifier.
4. If no number, do step 8.
5. Obtain the new input cost values.
6. Update the cost matrix with the new values.
7. Repeat from step 3.

Extended Description

9. Sum the costs across cost-components for each item and store these values in the appropriate column of the RAM matrix.

System/Program: BUILDRAM Name:

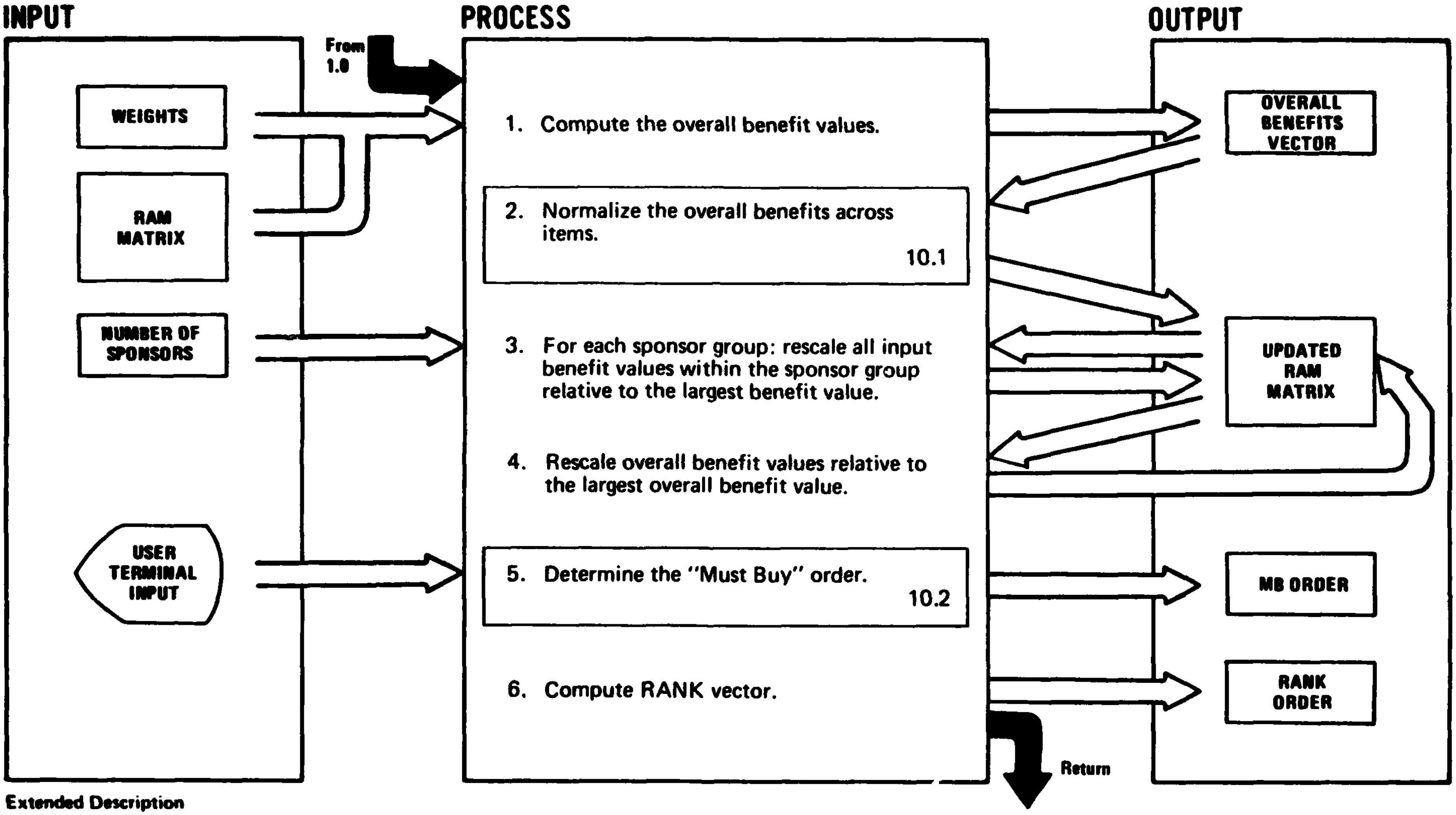
Diagram ID: 9.5 Description Edit Cost Data Page: 2 of 2



8. Prompt for edit completion. If not complete, repeat 2.
9. Update RAM matrix with total costs and return.

System/Program: BUILDRAM Name:

Diagram ID: 10.0 Description Calculate Results Page: of



1. Compute the overall benefit values.

2. Normalize the overall benefits across items. 10.1

3. For each sponsor group: rescale all input benefit values within the sponsor group relative to the largest benefit value.

4. Rescale overall benefit values relative to the largest overall benefit value.

5. Determine the "Must Buy" order. 10.2

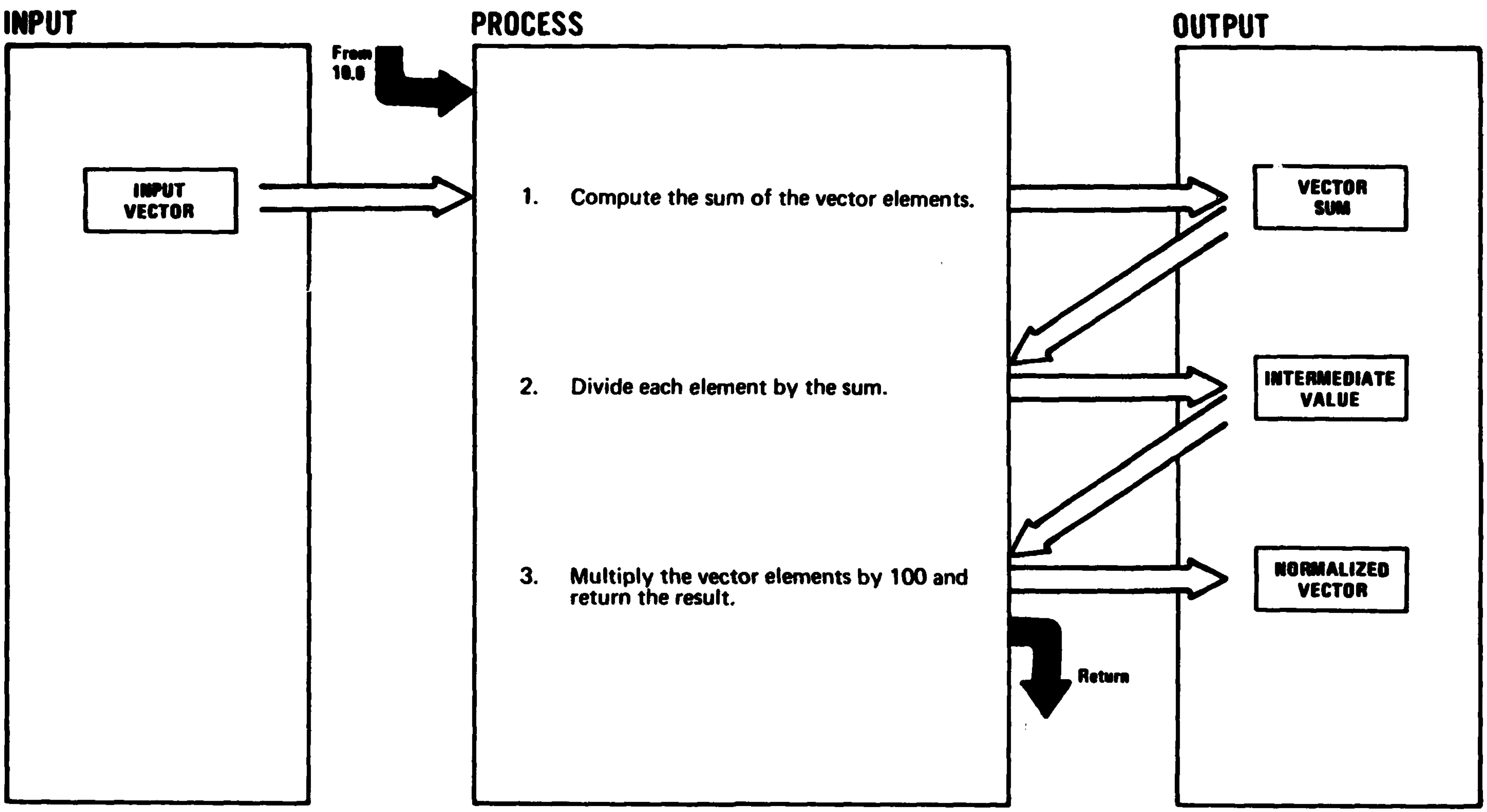
6. Compute RANK vector.

Extended Description

1. Overall benefit values are computed by multiplying each sponsor-item benefit values by its fractional component in the WEIGHTS vector.

System/Program: BUILDRAM Name: Normalize

Diagram ID: 10.1 Description Normalize Overall Benefits Page: ___ of ___



1. Compute the sum of the vector elements.

2. Divide each element by the sum.

3. Multiply the vector elements by 100 and return the result.

Extended Description

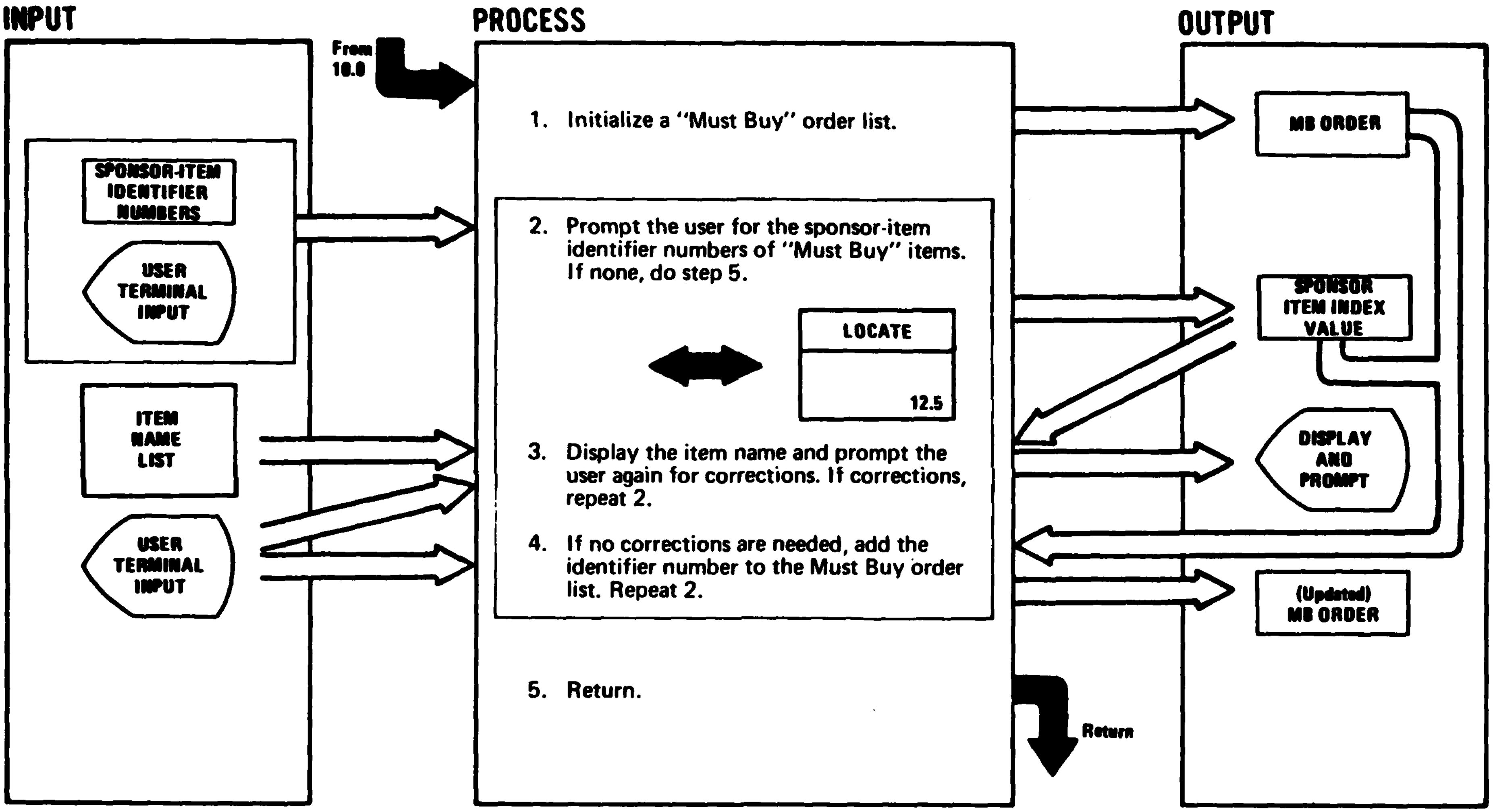
1. The input to this routine is a vector or row of numbers (otherwise, input will be converted to a numerical string of values). The sum of all the numbers in the vector is computed.

2. This step rescales all of the values to their percentage of the sum.

3. The normalized result from step 2 is typically multiplied by 100 to preserve percentage figures for output to the calling routines.

System/Program: BUILDRAM Name: MUST BUY

Diagram ID: 10.2 Description Process the Must Buy Option Page: ___ of ___



1. Initialize a "Must Buy" order list.

2. Prompt the user for the sponsor-item identifier numbers of "Must Buy" items. If none, do step 5.

3. Display the item name and prompt the user again for corrections. If corrections, repeat 2.

4. If no corrections are needed, add the identifier number to the Must Buy order list. Repeat 2.

5. Return.

Extended Description

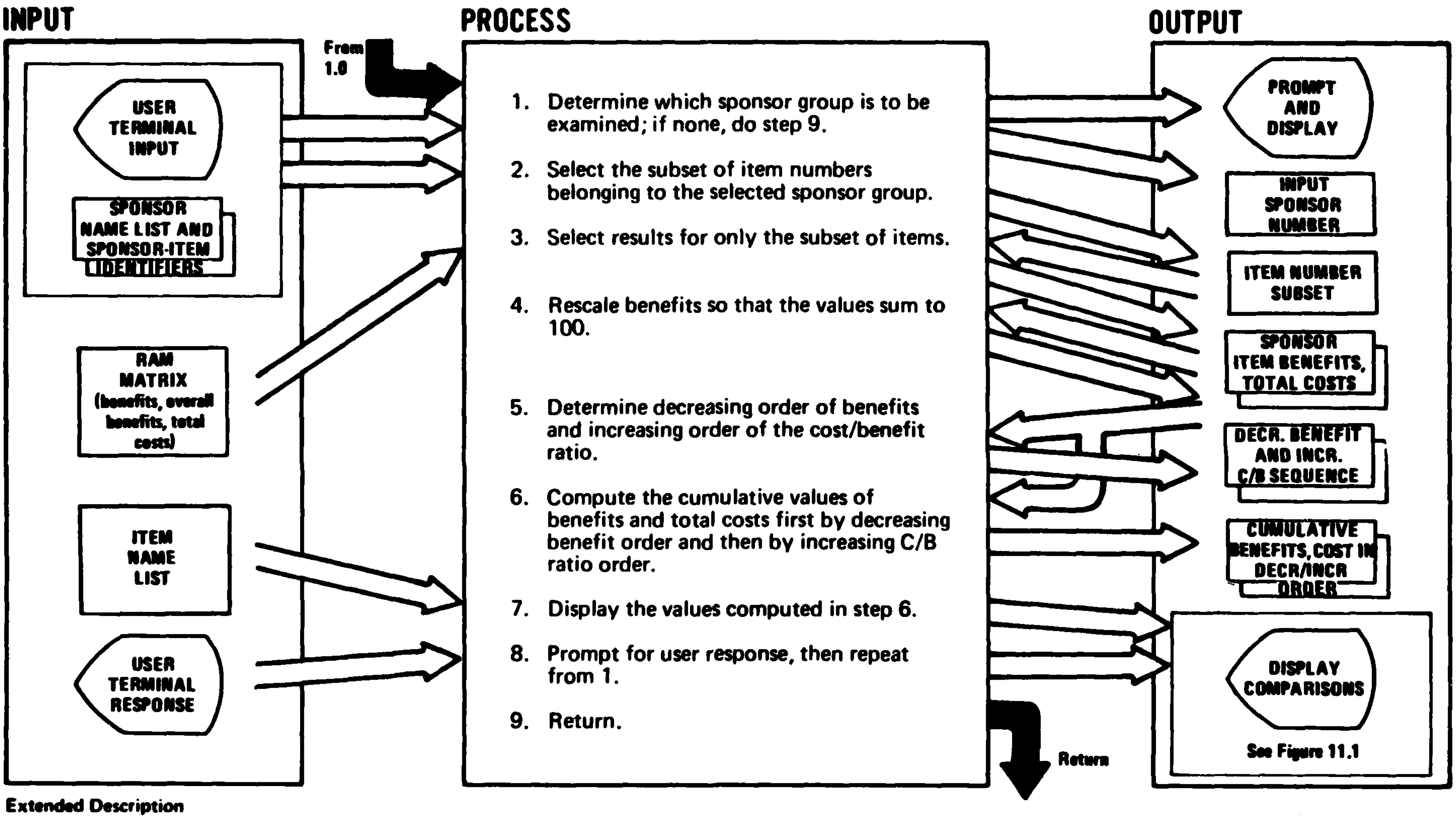
1. Create a vector with the same number of elements as there are number of items in the current model. Initialize the vector elements to zero.

2. Invoke the LOCATE subroutine (see diagram 12.5) to obtain from the user the sponsor-item identifier numbers and thereby derive the item index value for the requested item.

4. Place the item index value in the first available zero position of the "Must Buy" order vector (MB vector).

System/Program: BUILDRAM Name: ______

Diagram ID: 11.0 Description Compare Benefits With C/B Page: ___ of ___



INPUT
PROCESS
OUTPUT
USER TERMINAL INPUT
SPONSOR NAME LIST AND SPONSOR-ITEM IDENTIFIERS
RAM MATRIX (benefits, overall benefits, total costs)
ITEM NAME LIST
USER TERMINAL RESPONSE
From 1.0
Return
PROMPT AND DISPLAY
INPUT SPONSOR NUMBER
ITEM NUMBER SUBSET
SPONSOR ITEM BENEFITS, TOTAL COSTS
DECR. BENEFIT AND INCR. C/B SEQUENCE
CUMULATIVE BENEFITS, COST IN DECR/INCR ORDER
DISPLAY COMPARISONS
See Figure 11.1

1. Determine which sponsor group is to be examined; if none, do step 9.
2. Select the subset of item numbers belonging to the selected sponsor group.
3. Select results for only the subset of items.
4. Rescale benefits so that the values sum to 100.
5. Determine decreasing order of benefits and increasing order of the cost/benefit ratio.
6. Compute the cumulative values of benefits and total costs first by decreasing benefit order and then by increasing C/B ratio order.
7. Display the values computed in step 6.
8. Prompt for user response, then repeat from 1.
9. Return.

Extended Description

1. The user is prompted to specify a sponsor group name (or number) for the analysis. If a blank entry is given, then the routine terminates at step 9. Otherwise, steps 2–8 are processed.

4. The sponsor's item benefit values are all divided by the sum of the sponsor's item benefit values and then multiplied by 100.

5. The set of item index values are obtained which specify the numerical decreasing sequence order of benefit values. Another set of item index values are obtained which specify the increasing order of the computed total cost to benefit ratio per item.

6. The benefit values and the total cost values for the items which are indexed by the decreasing (step 5) benefit order are accumulated. Next, the benefit and total cost values for items which are indexed by the increasing C/B ratio order defined in step 5 are accumulated.

7. Cumulative values displayed are the first value of the specified order, then the first plus the second value of the indexed order, etc. . .

```
   ORDERED BY         CUMULATIVE      CUMULATIVE         ORDERED BY
    BENEFIT         BENEFIT  COST   COST  BENEFIT      COST-BENEFIT


CAREER PLACEMENT      35      44.0  44.0     35      CAREER PLACEMENT
  CTR                                                  CTR
                                    73.0     42      EXTRACURRICULAR
                                   125.0     53      STUDENT CENTER
                                   156.0     58      HOUSING GUIDE
                                   266.0     74      COUNSELING PROGRAM

HEALTH SERVICES       61     322.0
COUNSELING            77     432.0
  PROGRAM
STUDENT CENTER        88     484.0
EXTRACURRICULAR       95     513.0
HOUSING GUIDE        100     544.0 544.0    100      HEALTH SERVICES

PLEASE RETURN CARRIAGE TO CONTINUE
```

HIPO Figure 11.1

COST-BENEFIT VS. BENEFIT-ONLY DISPLAY

System/Program: BUILDRAM Name:

Diagram ID: 12.0 Description Generalized Routines Page: ___ of ___

INPUT

PROCESS

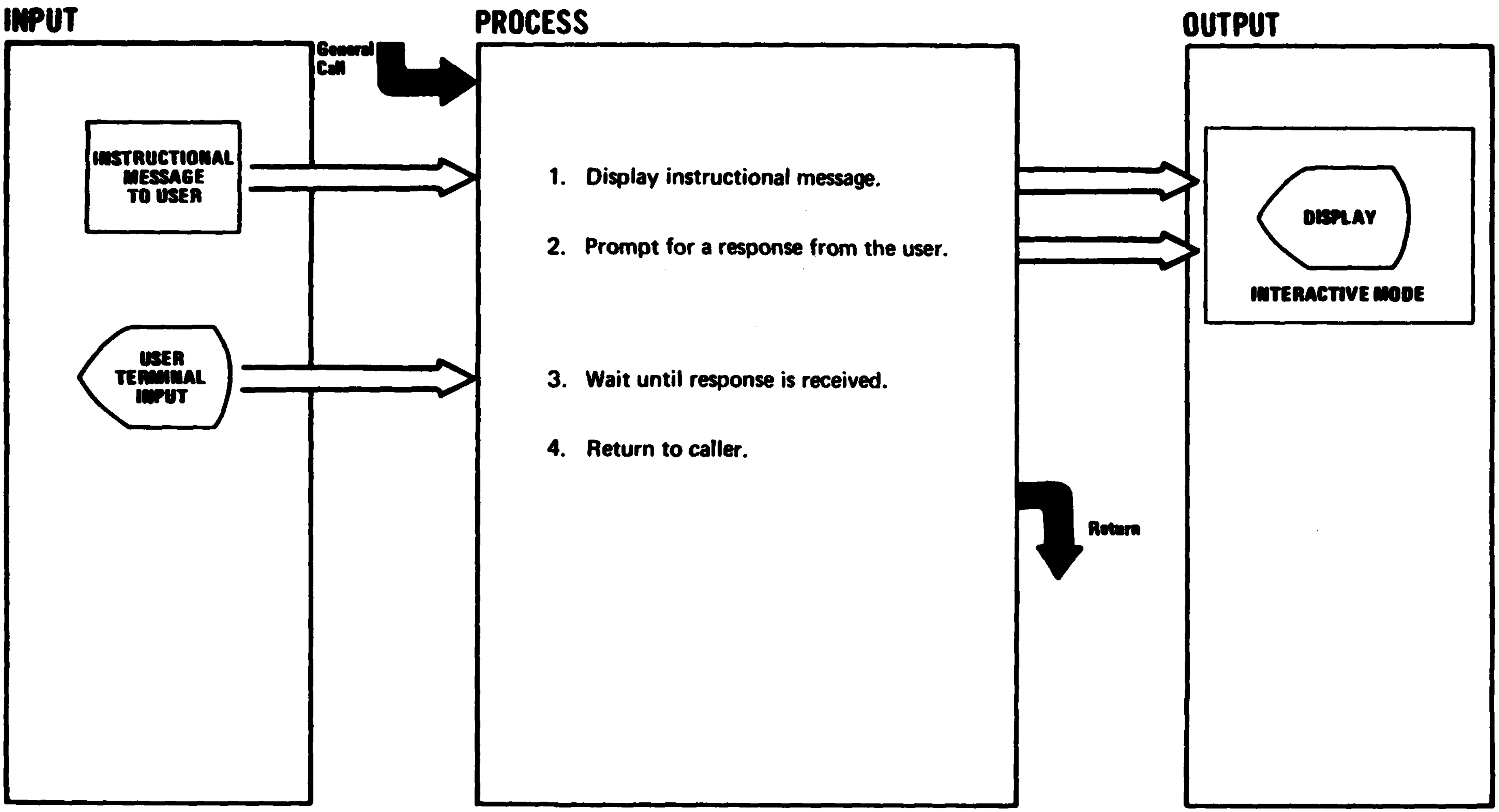
OUTPUT

Extended Description

Generalized routines are directly invoked by functional procedures and return to the calling programs.

System/Program: BUILDRAM Name: Wait

Diagram ID: 12.1 Description Wait for a Response Page: ___ of ___



INPUT

PROCESS

OUTPUT

1. Display instructional message.

2. Prompt for a response from the user.

3. Wait until response is received.

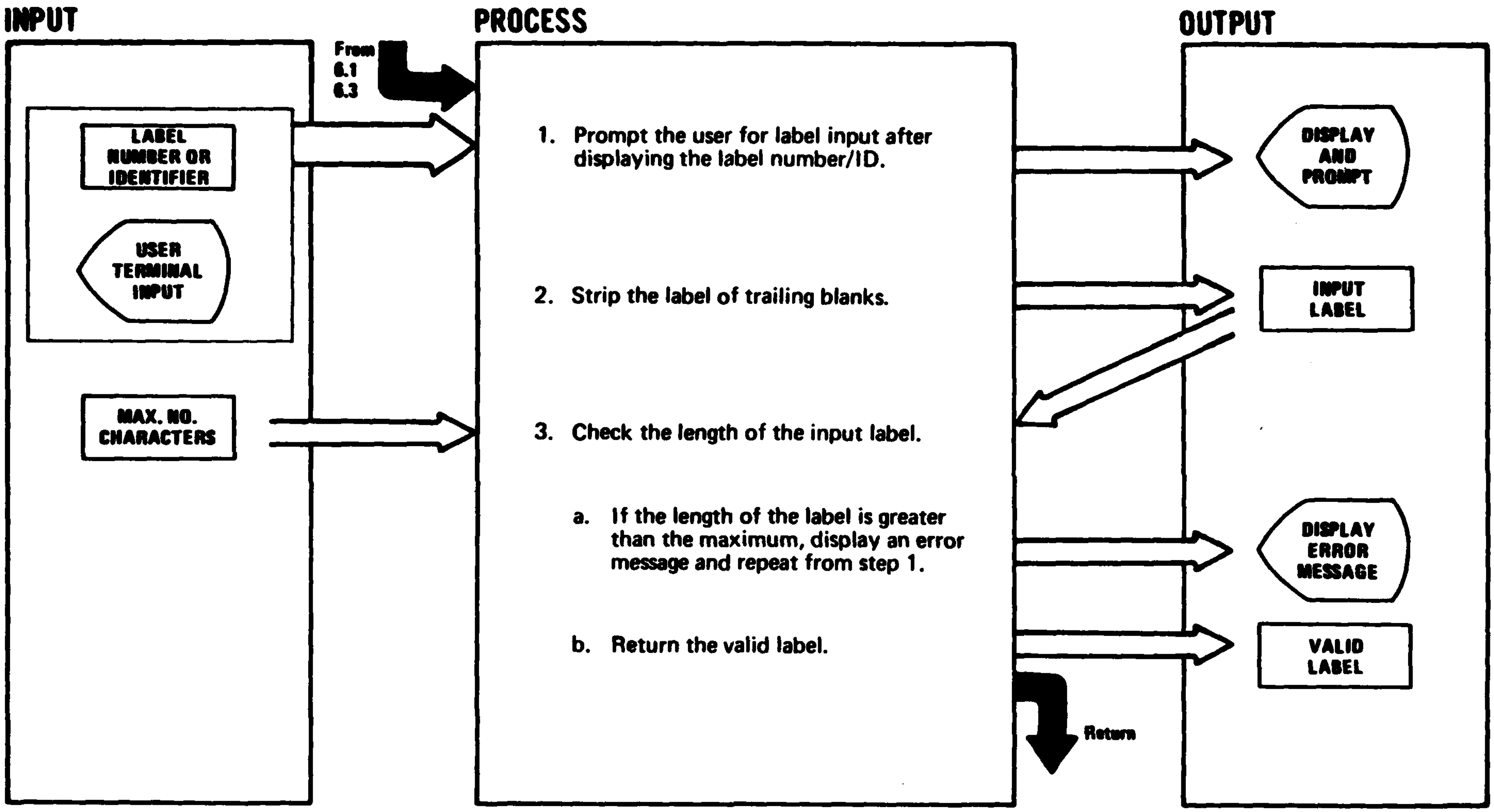
4. Return to caller.

This routine is used for display purposes to enhance user control over changing displays.

3. Any keyboard input or a specific response may be requested of the user before processing can continue.

System/Program: BUILDRAM Name:

Diagram ID: 12.2 Description Enter Labels Routine Page: of



INPUT

PROCESS

OUTPUT

1. Prompt the user for label input after displaying the label number/ID.

2. Strip the label of trailing blanks.

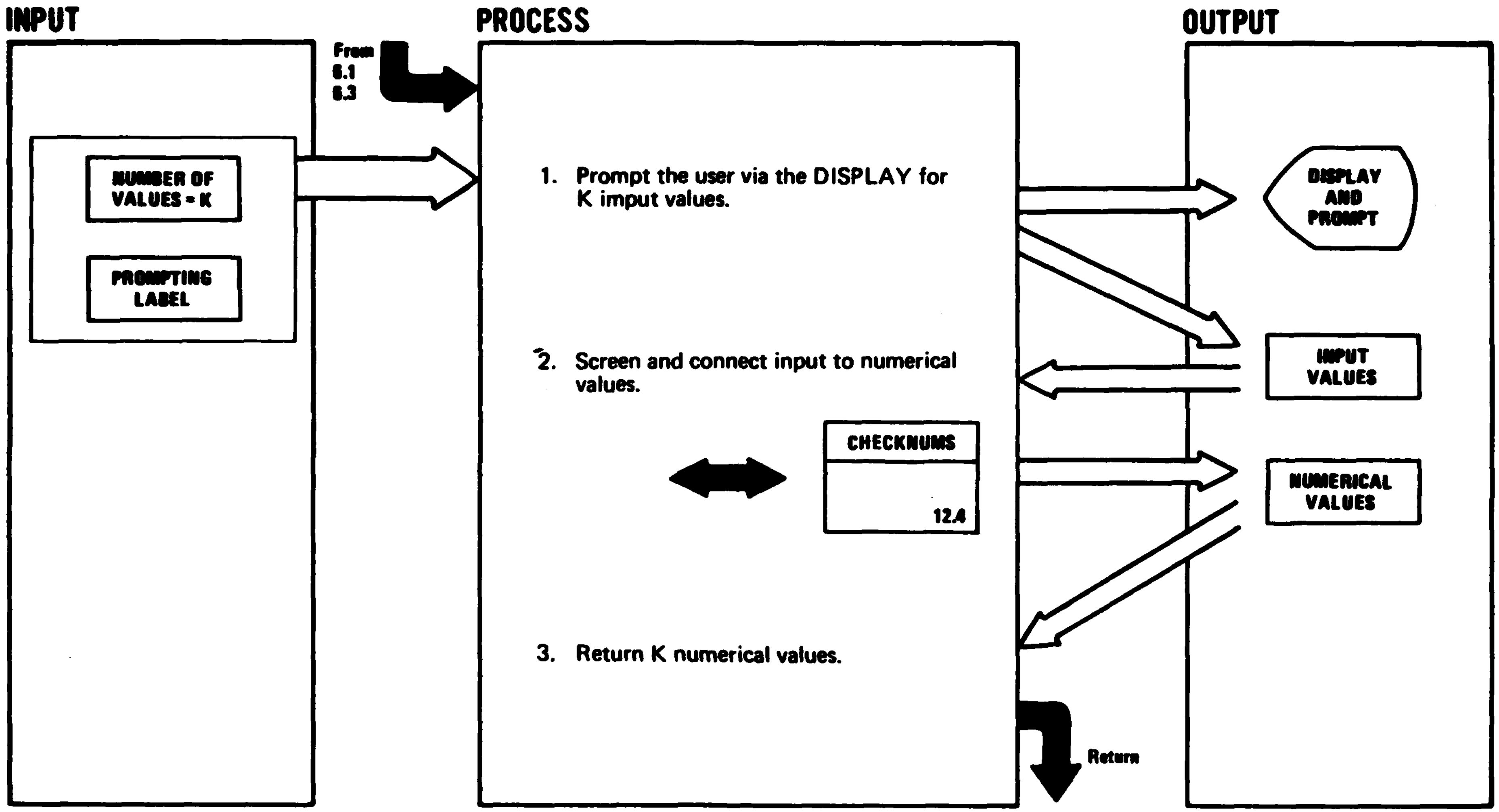
3. Check the length of the input label.

   a. If the length of the label is greater than the maximum, display an error message and repeat from step 1.

   b. Return the valid label.

System/Program: BUILDRAM Name: ENTERLINE

Diagram ID: 12.3 Description Enter Line Routine Page: ___ of ___



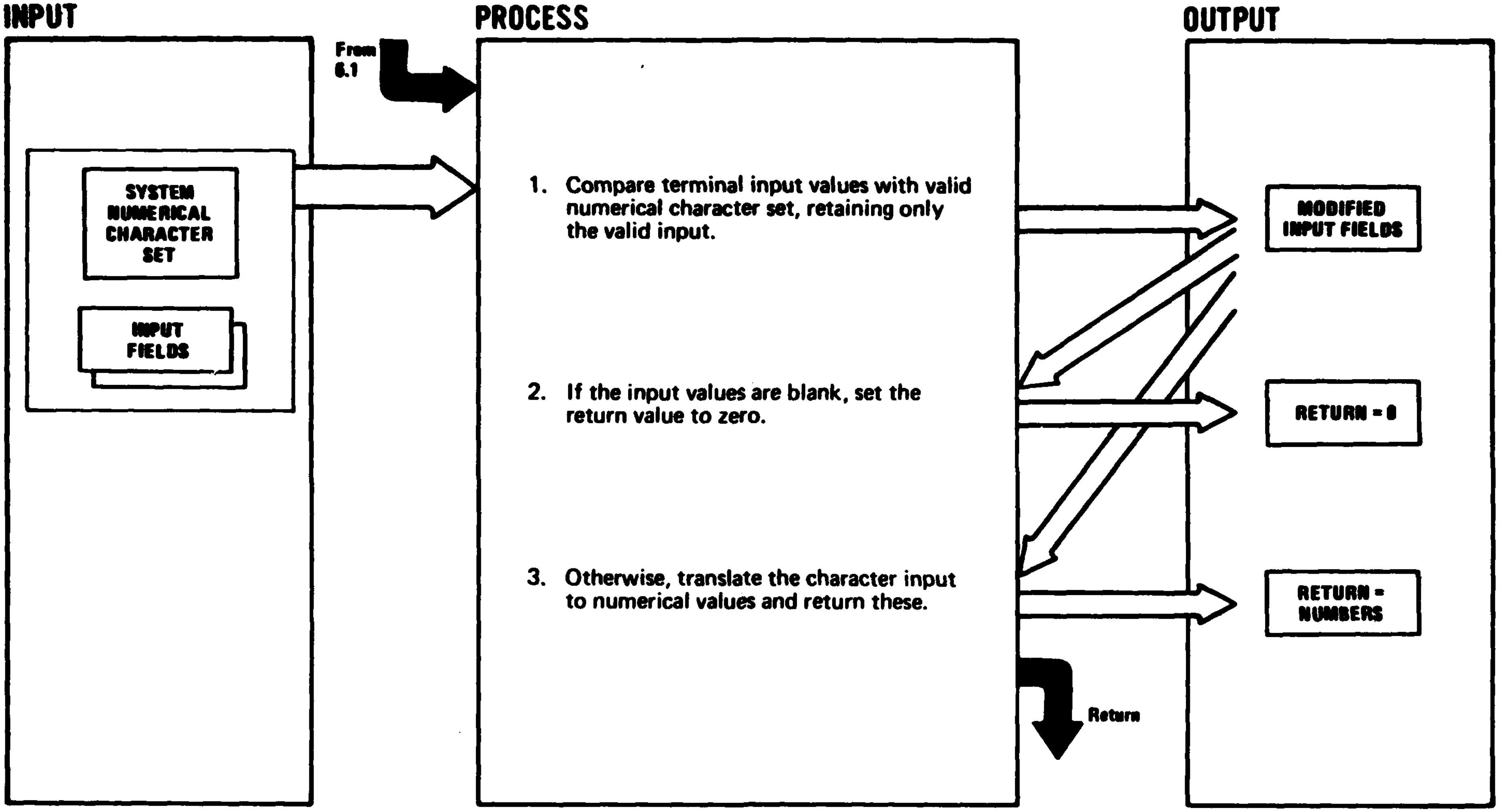
1. Prompt the user via the DISPLAY for K imput values.

2. Screen and connect input to numerical values.

3. Return K numerical values.

System/Program: BUILDRAM Name: CHKNUMS

Diagram ID: 12.4 Description Check Numerical Values Page: ___ of ___



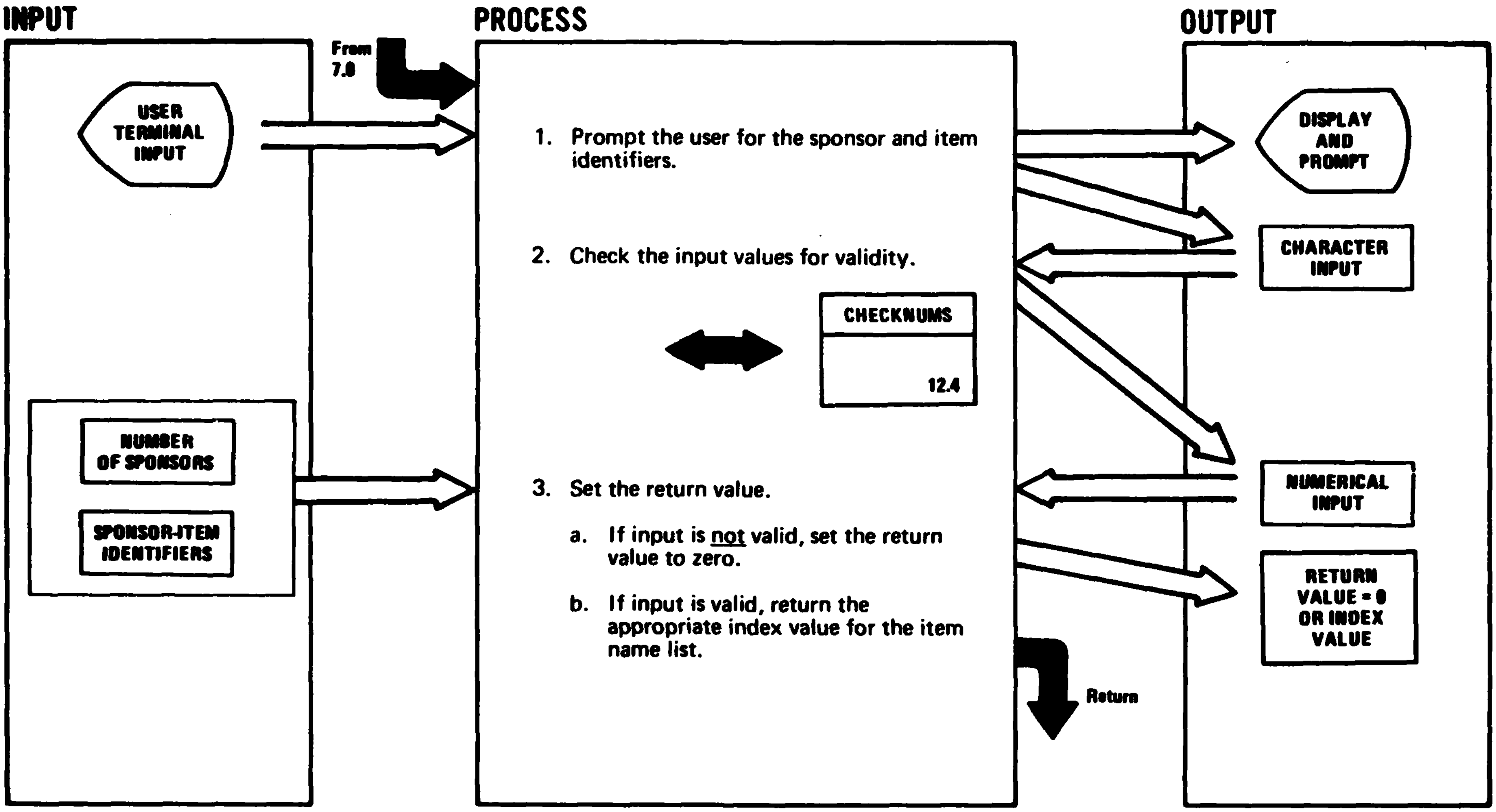
1. Compare terminal input values with valid numerical character set, retaining only the valid input.

2. If the input values are blank, set the return value to zero.

3. Otherwise, translate the character input to numerical values and return these.

System/Program: BUILDRAM Name: Locate

Diagram ID: 12.5 Description Locate a Sponsor Item Page: ___ of ___



1. Prompt the user for the sponsor and item identifiers.
2. Check the input values for validity.
3. Set the return value.
   a. If input is not valid, set the return value to zero.
   b. If input is valid, return the appropriate index value for the item name list.

Extended Description

1. Display a request to the user to input the sponsor identification number and the sponsor item number for the desired cost item.

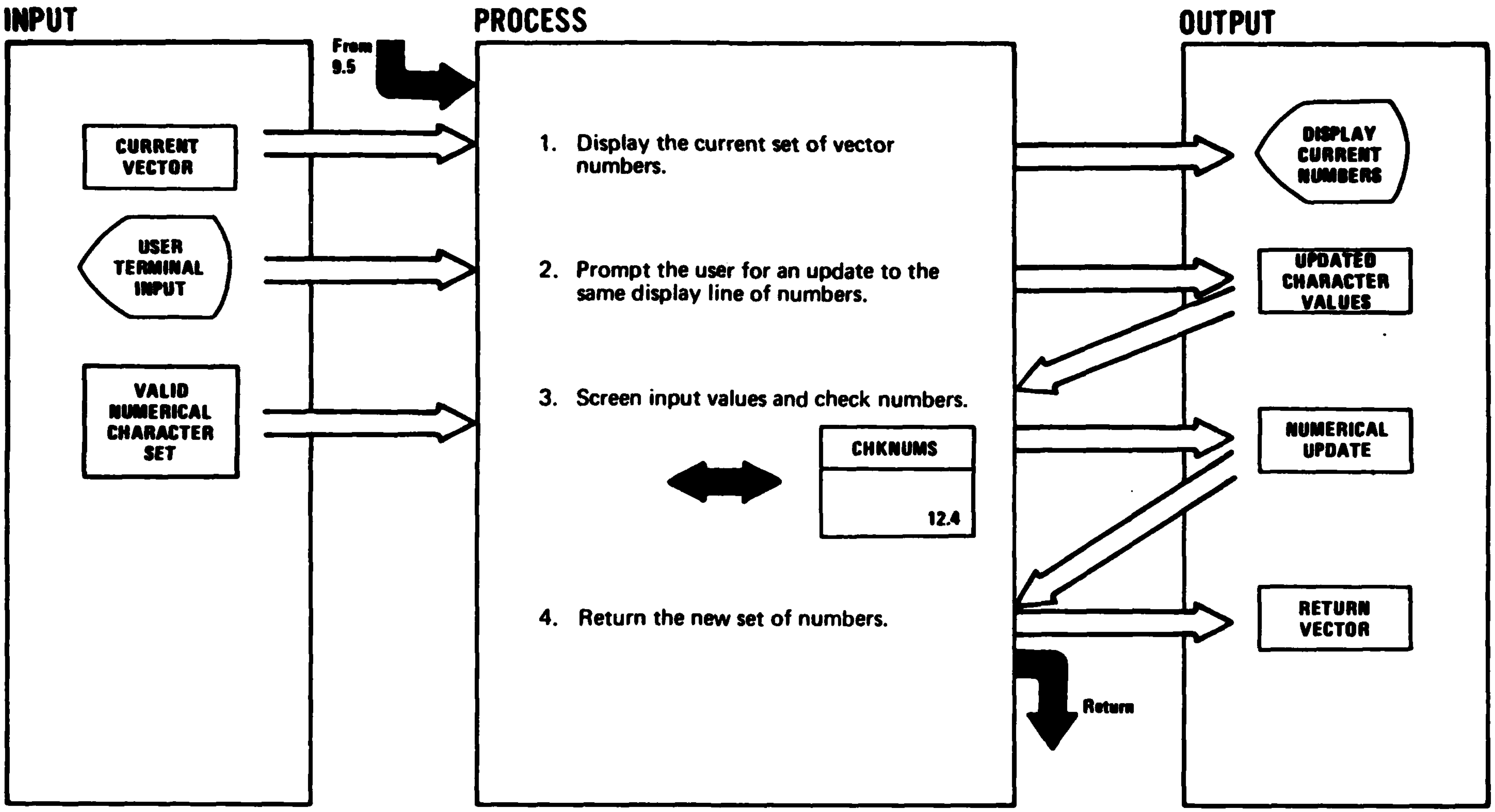
2. Call the CHECKNUMS subroutine (see diagram 12.4) for a screening of the input values. The subroutine returns numerical input that has been decoded from the terminal keyboard input field.

3. If the resulting numerical input is zero, return a zero value to the calling routine. Also, the numerical values should be compared with the valid sponsor and sponsor item identifiers in the model; invalid input results in a zero return value.

For valid input values, the sponsor and item numbers are combined to allow the computation of the appropriate index value for this item into the item name list, RAM and COST matrices.

System/Program: BUILDRAM Name: EDITLINE

Diagram ID: 12.6 Description Edit a Line of Numbers Page: ___ of ___



1. Display the current set of vector numbers.
2. Prompt the user for an update to the same display line of numbers.
3. Screen input values and check numbers.
4. Return the new set of numbers.

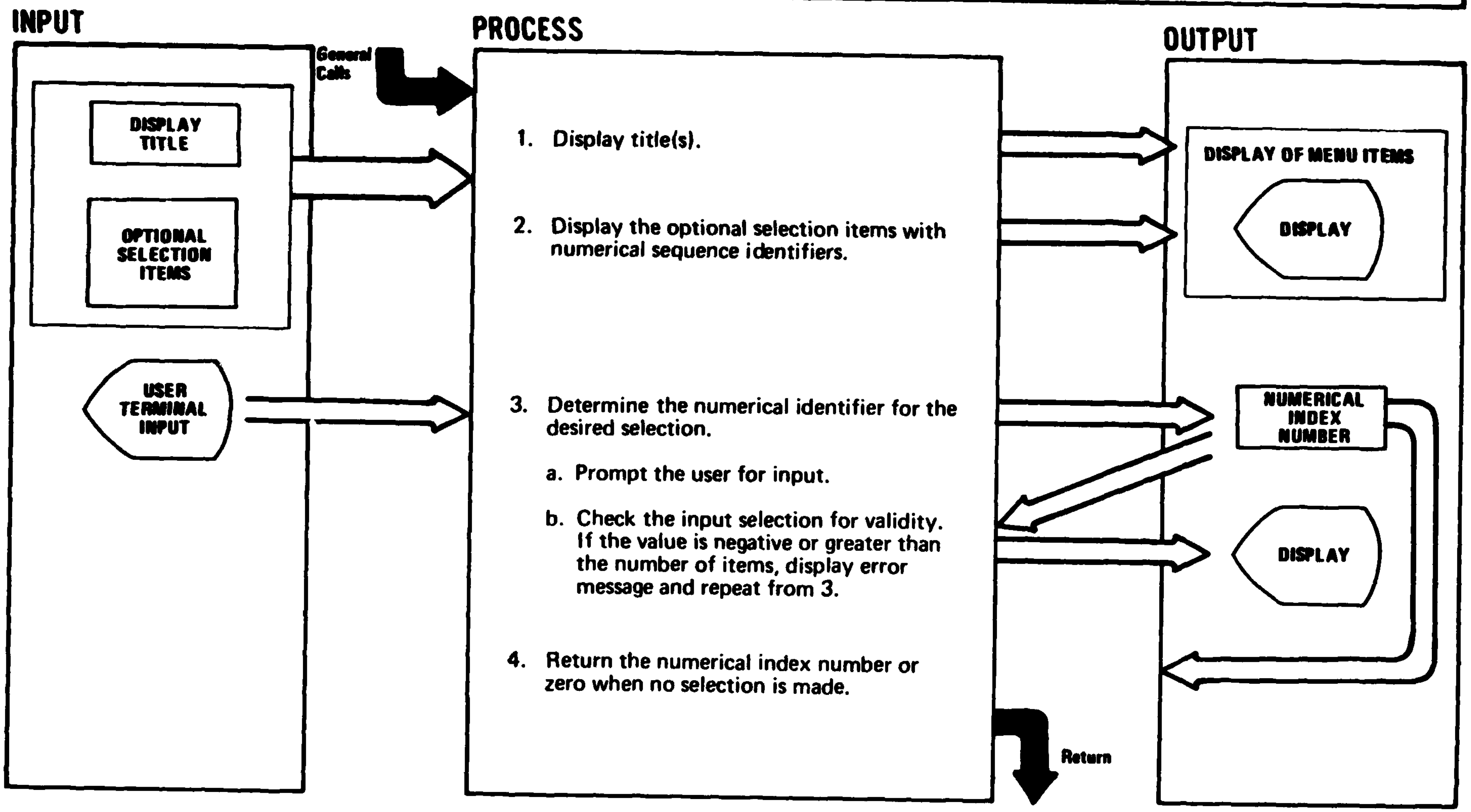
Extended Description

This routine differs from the "ENTERLINE" routine in that it attempts to read input values from the previously displayed line location.

System/Program: BUILDRAM Name: MENU

Diagram ID: 12.7 Description Display Menu/List Routine

Page: ___ of ___



1. Display title(s).

2. Display the optional selection items with numerical sequence identifiers.

3. Determine the numerical identifier for the desired selection.

   a. Prompt the user for input.

   b. Check the input selection for validity. If the value is negative or greater than the number of items, display error message and repeat from 3.

4. Return the numerical index number or zero when no selection is made.

1. The title is passed to this routine so that the display will remain in context with the processing function. For example, a title may be 'DISPLAY RESULTS'.

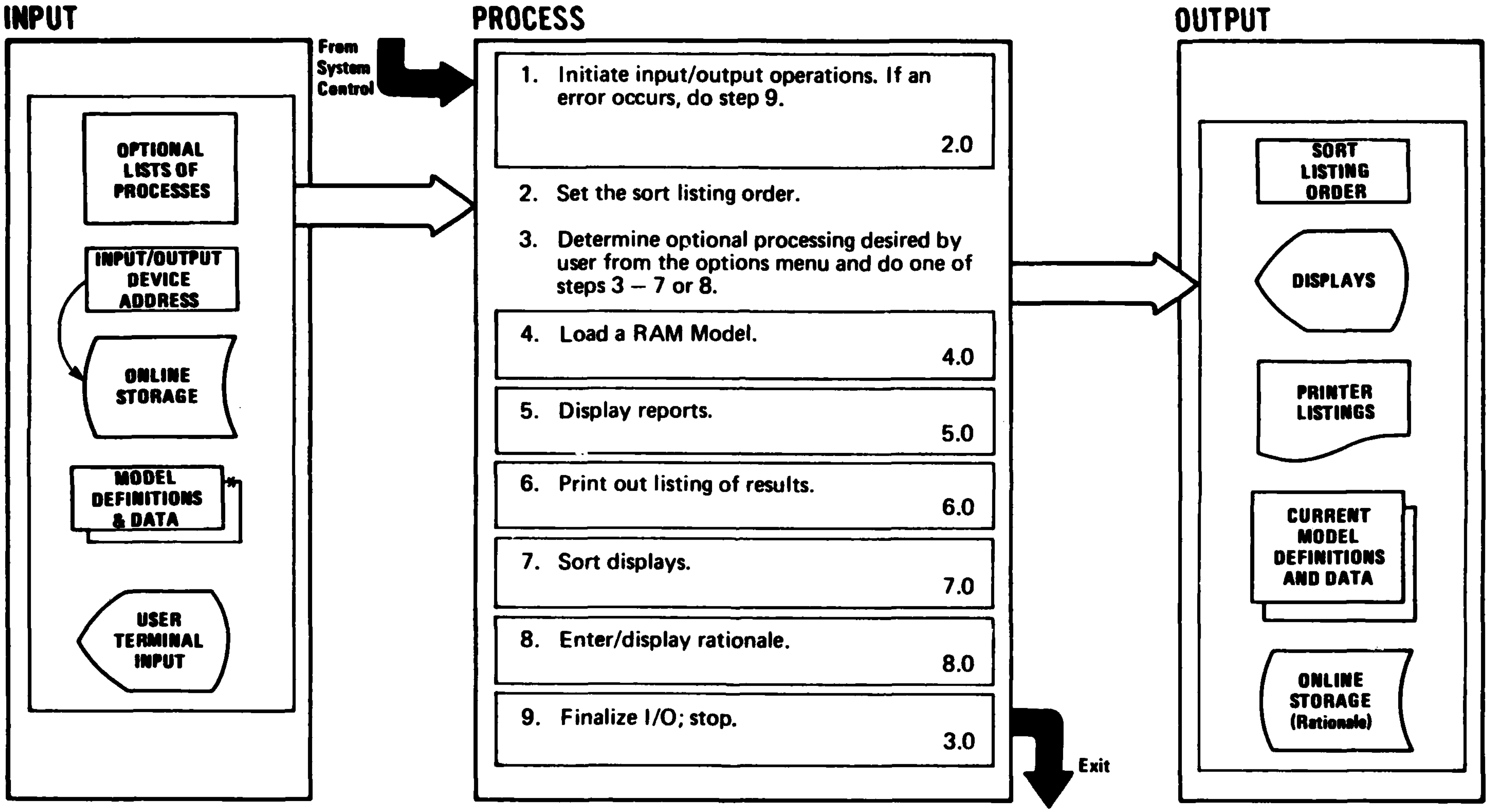
2. The selections that describe what is optimal are passed as input and are displayed in a list or cookbook MENU format along with item sequence numbers.

3. Prompt the user for the item sequence number of the choice selection.

Check the validity of the user input.

System/Program: REPRAM Name: REPRAM (RAM Reports)

Diagram ID: 1.0 Description RAM Report Main Program Page: ___ of ___



1. Initiate input/output operations. If an error occurs, do step 9. 2.0
2. Set the sort listing order.
3. Determine optional processing desired by user from the options menu and do one of steps 3 – 7 or 8.
4. Load a RAM Model. 4.0
5. Display reports. 5.0
6. Print out listing of results. 6.0
7. Sort displays. 7.0
8. Enter/display rationale. 8.0
9. Finalize I/O; stop. 3.0

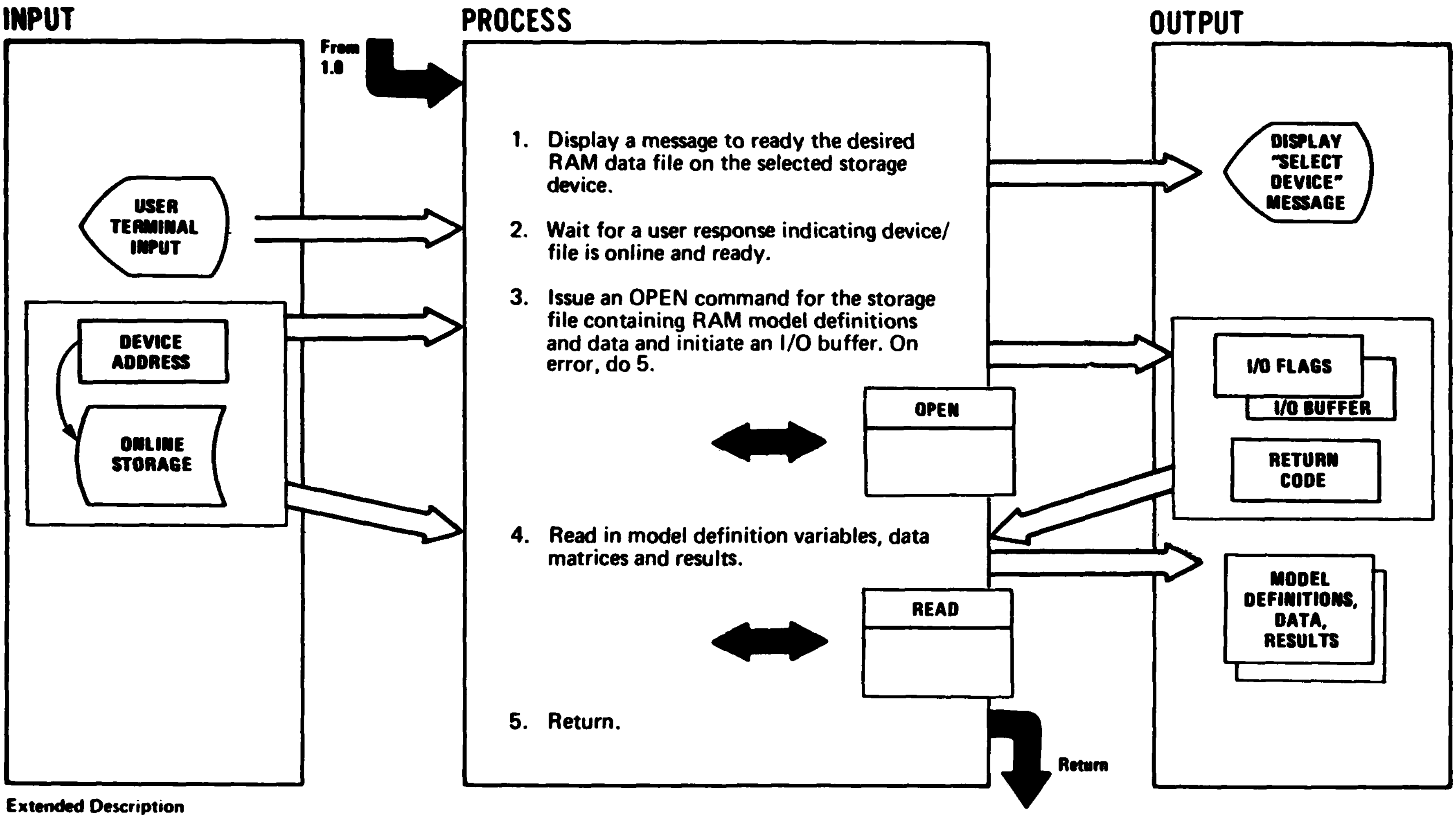
Extended Description

The REPRAM subsystem may be entered from system control seperate from the BUILD/DISPLAY section of the program. The functional procedures described in diagrams 2.0, 3.0, and 4.0 of the BUILD/DISPLAY section describe steps 2, 9 and 4, respectively of this diagram.

2. The sort listing order is a pre-defined report output sequence of item identification numbers and has been defined according to a previous ordering (sorting); for example, decreasing Cost/Benefit ratio values is one such ordering. When the program begins, this step sets the sort listing order to depict increasing sponsor-item identifier numbers.

System Program: REPRAM Name:

Diagram ID: 2.0 Description: Initiate I/O Page: ___ of ___



1. Display a message to ready the desired RAM data file on the selected storage device.

2. Wait for a user response indicating device/file is online and ready.

3. Issue an OPEN command for the storage file containing RAM model definitions and data and initiate an I/O buffer. On error, do 5.

4. Read in model definition variables, data matrices and results.

5. Return.

Extended Description

1. The device address of online storage which contains the RAM data and model definitions is available at the start of program processing. It is either encoded in the program or requested from the user. It is assumed that only one RAM data set is available per dev/file address (i.e. diskette, drum cylinder, etc.)

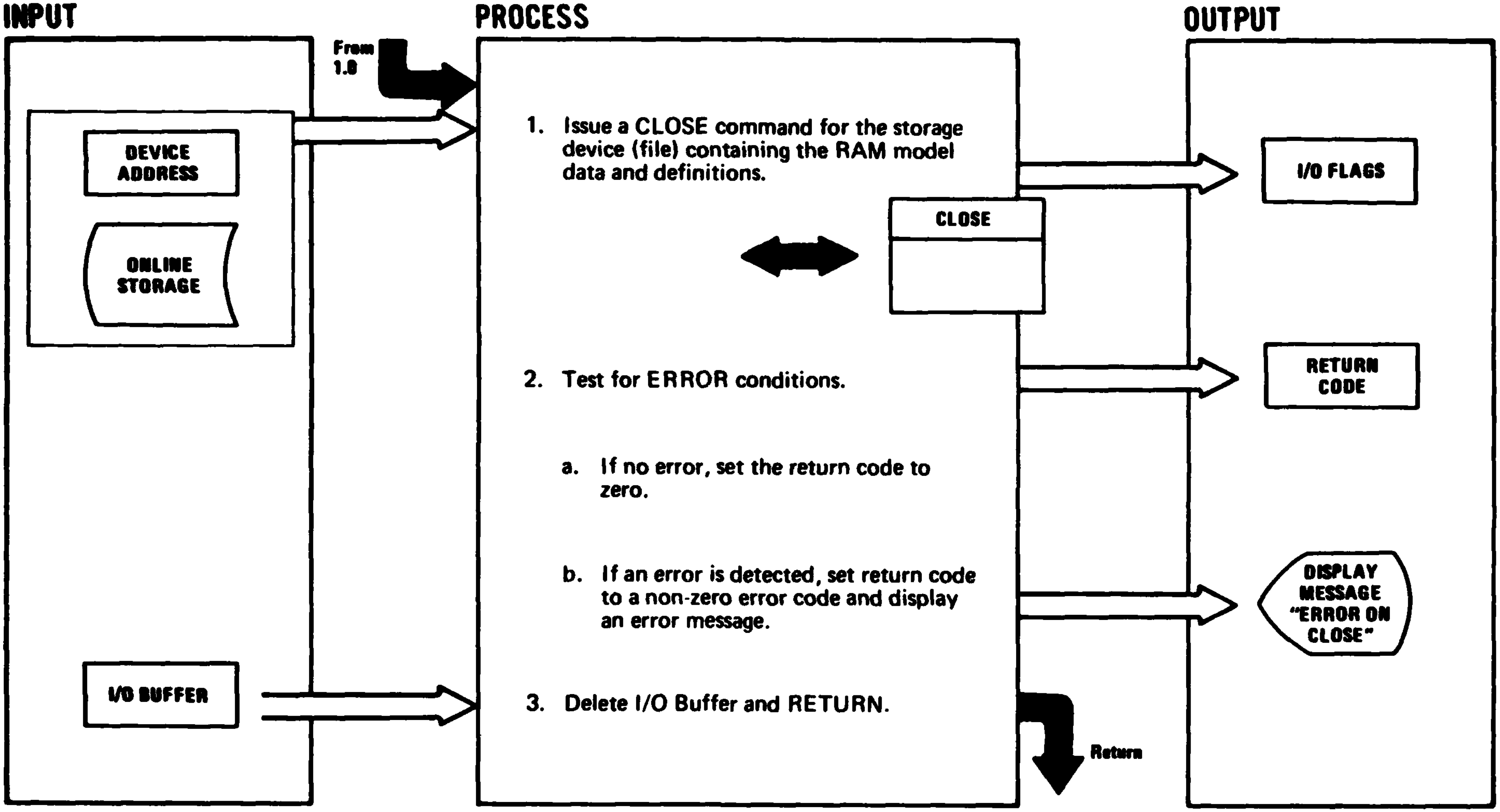
3. A system device OPEN command is required in order to access the RAM model and data. The interface with the system OPEN routine should be OPEN's setting of I/O flags in (or adjacent to) and I/O buffer area to denote the success or failure of access to the device.

If an error condition is detected, a non-zero error code is returned to the caller.

4. Model variables are read according to a preset order which is identical to the manner in which the variables are stored (see diagram 4.2).

System/Program: REPRAM Name:

Diagram ID: 3.0 Description Finalize I/O Page: of



1. Issue a CLOSE command for the storage device (file) containing the RAM model data and definitions.

2. Test for ERROR conditions.

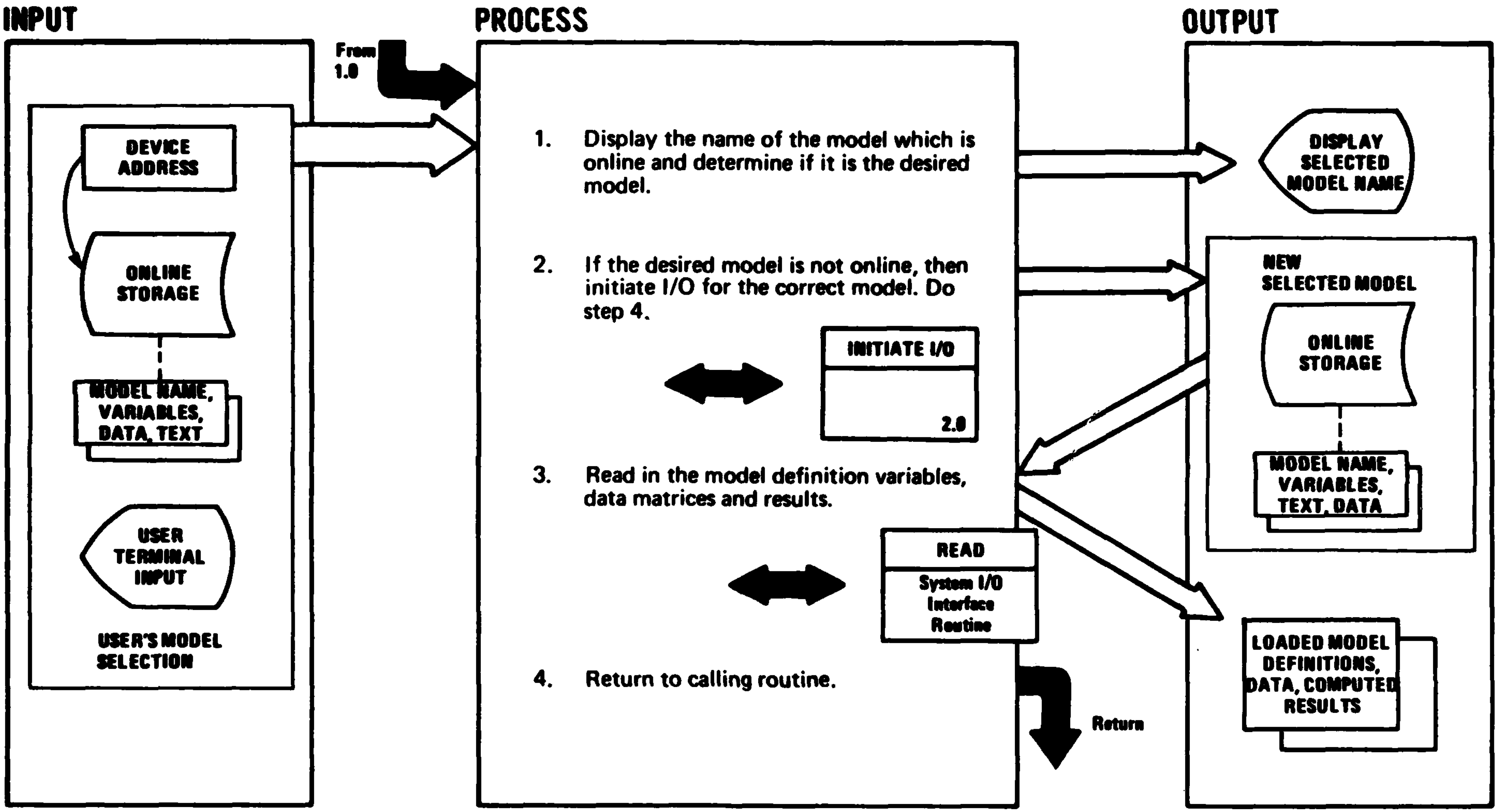
   a. If no error, set the return code to zero.

   b. If an error is detected, set return code to a non-zero error code and display an error message.

3. Delete I/O Buffer and RETURN.

System/Program: REPRAM Name:

Diagram ID: 4.0 Description Load a Model Page: of


INPUT
DEVICE ADDRESS
ONLINE STORAGE
MODEL NAME, VARIABLES, DATA, TEXT
USER TERMINAL INPUT
USER'S MODEL SELECTION
From 1.0
PROCESS
INITIATE I/O
2.0
READ
System I/O Interface Routine
Return
OUTPUT
DISPLAY SELECTED MODEL NAME
NEW SELECTED MODEL
ONLINE STORAGE
MODEL NAME, VARIABLES, TEXT, DATA
LOADED MODEL DEFINITIONS, DATA, COMPUTED RESULTS

1. Display the name of the model which is online and determine if it is the desired model.

2. If the desired model is not online, then initiate I/O for the correct model. Do step 4.

3. Read in the model definition variables, data matrices and results.

4. Return to calling routine.

Extended Description

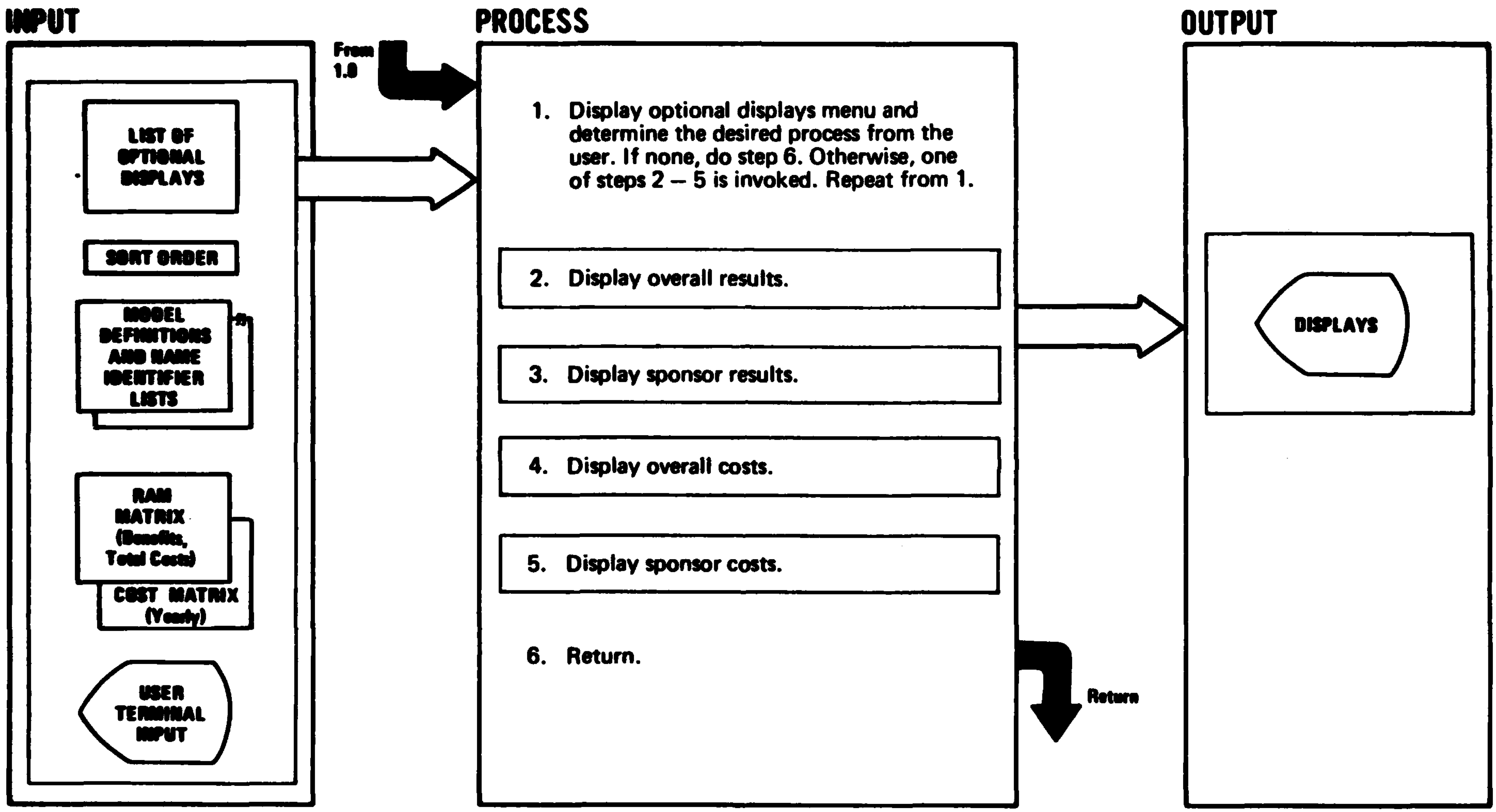
1. The user has the option of switching the online device/file at this time, since only one RAM model is stored per device/file.

2. If the desired device is not already online, then the appropriate one must be placed online and opened for input (see diagram 2.0). An input buffer is created for the newly selected model.

3. Read data commands are issued for the required model definition and data variables. This is accomplished according to an encoded variable list and in the same order as the data items are stored.

System/Program: REPRAM Name:

Diagram ID: 5.0 Description Display Reports Page: ____ of ____


INPUT
LIST OF OPTIONAL DISPLAYS
SORT ORDER
MODEL DEFINITIONS AND NAME IDENTIFIER LISTS
RAM MATRIX (Benefits, Total Costs)
COST MATRIX (Yearly)
USER TERMINAL INPUT
From 1.0
PROCESS
Return
OUTPUT
DISPLAYS

1. Display optional displays menu and determine the desired process from the user. If none, do step 6. Otherwise, one of steps 2 – 5 is invoked. Repeat from 1.

2. Display overall results.

3. Display sponsor results.

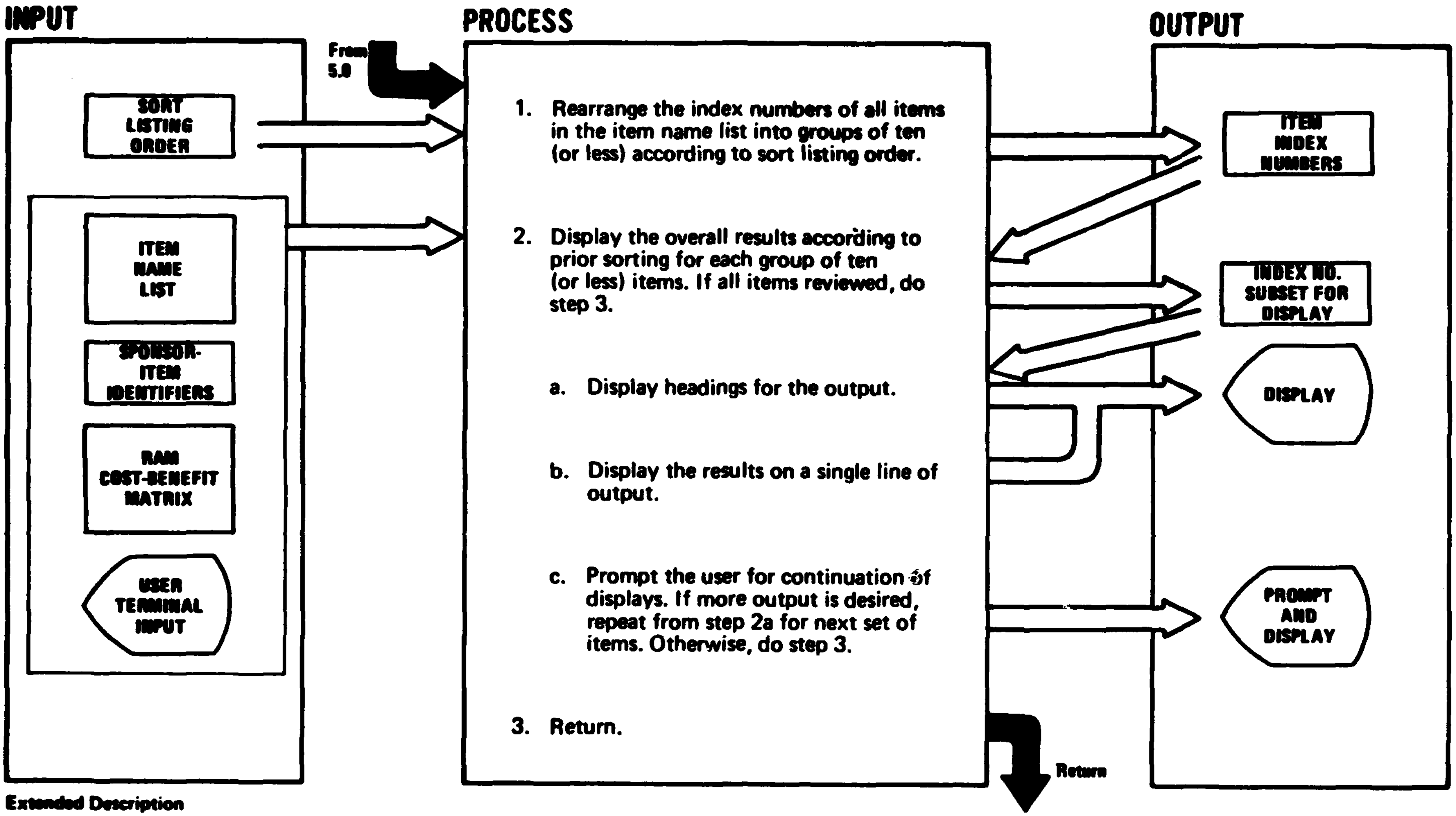
4. Display overall costs.

5. Display sponsor costs.

6. Return.

System/Program: REPRAM Name:

Diagram ID: 5.1 Description Display Overall Results Page: of



1. Rearrange the index numbers of all items in the item name list into groups of ten (or less) according to sort listing order.

2. Display the overall results according to prior sorting for each group of ten (or less) items. If all items reviewed, do step 3.

   a. Display headings for the output.

   b. Display the results on a single line of output.

   c. Prompt the user for continuation of displays. If more output is desired, repeat from step 2a for next set of items. Otherwise, do step 3.

3. Return.

Extended Description

The format for the displays requires the listing of results for a maximum of ten (10) items at a time. The user is allowed to discontinue the display of results afer each set of ten items is reviewed.

1. The index numbers of all the sponsor items in the currently loaded model are arranged by the currently specified sort listing order. (This sorting may have been changed recently via the SORT DISPLAYS option of the main program's MENU).

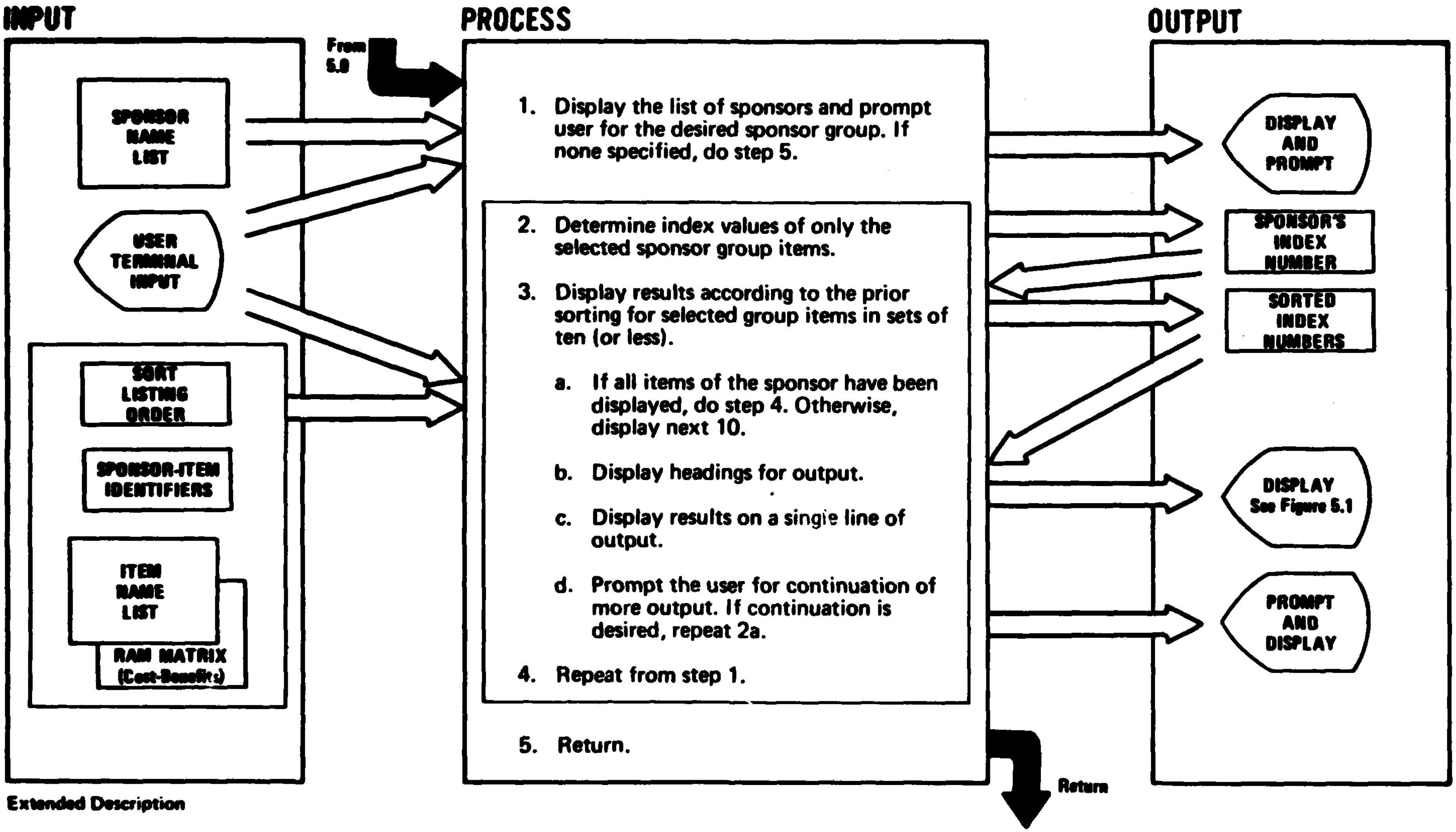
2 a. Display of the item results are preceded by the model name and result-type labels, such as "cost," "overall benefit," and "rank."

b. The information displayed per item includes the following:

- sponsor-item identifier
- item name
- benefit value
- overall (weighted) benefit value
- total cost per item
- cost/benefit ratio
- rank of C/B ratio among all items

System/Program: RAM Name:

Diagram ID: 5.2 Description Display Sponsor Results Page: of



1. Display the list of sponsors and prompt user for the desired sponsor group. If none specified, do step 5.

2. Determine index values of only the selected sponsor group items.

3. Display results according to the prior sorting for selected group items in sets of ten (or less).

   a. If all items of the sponsor have been displayed, do step 4. Otherwise, display next 10.

   b. Display headings for output.

   c. Display results on a single line of output.

   d. Prompt the user for continuation of more output. If continuation is desired, repeat 2a.

4. Repeat from step 1.

5. Return.

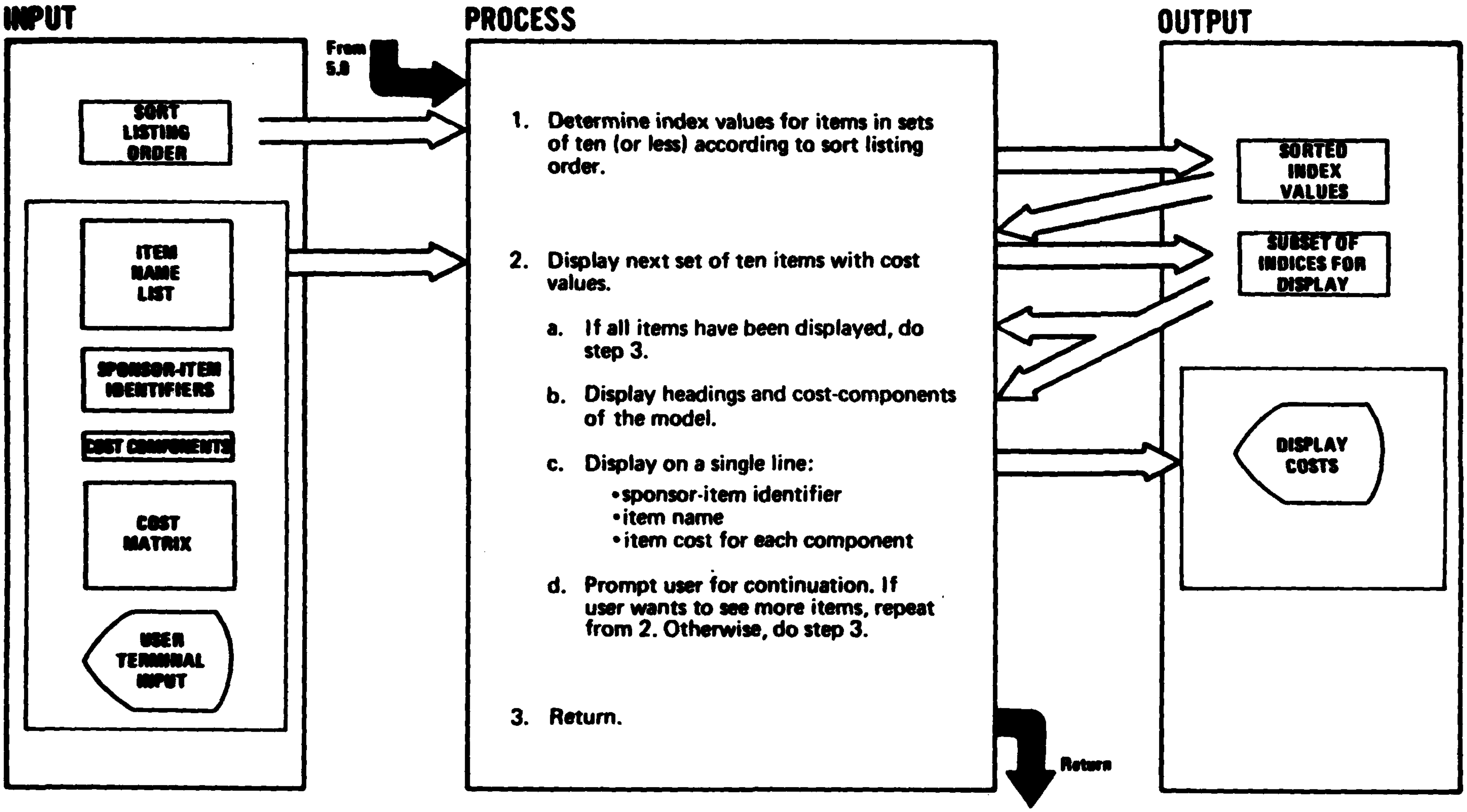
Extended Description

3. C. The information displayed per item includes the following:

- sponsor-item identifier number
- item name
- sponsor benefit value
- overall (weighted) benefit value
- total cost for the item
- the computed cost/benefit ratio
- the rank of the C/B ratio among all sponsor items

System/Program: REPRAM Name:

Diagram ID: 5.3 Description Display Overall Costs Page: ____ of ____



INPUT

SORT LISTING ORDER

ITEM NAME LIST

SPONSOR-ITEM IDENTIFIERS

COST COMPONENTS

COST MATRIX

USER TERMINAL INPUT

PROCESS

From 5.0

1. Determine index values for items in sets of ten (or less) according to sort listing order.

2. Display next set of ten items with cost values.

   a. If all items have been displayed, do step 3.

   b. Display headings and cost-components of the model.

   c. Display on a single line:
      - sponsor-item identifier
      - item name
      - item cost for each component

   d. Prompt user for continuation. If user wants to see more items, repeat from 2. Otherwise, do step 3.

3. Return.

Return

OUTPUT

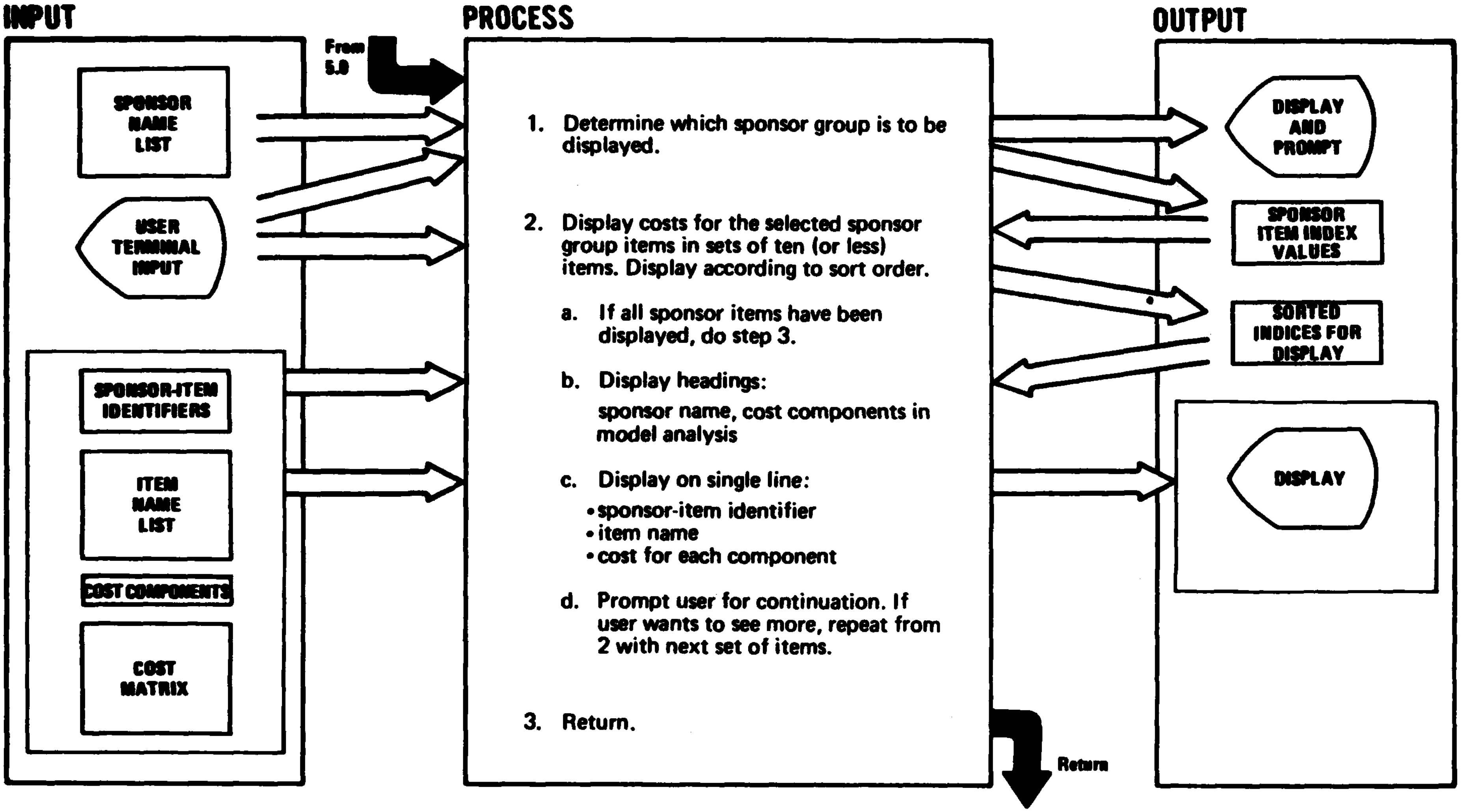
SORTED INDEX VALUES

SUBSET OF INDICES FOR DISPLAY

DISPLAY COSTS

System/Program: REPRAM Name:

Diagram ID: 5.4 Description Display Sponsor Costs Page: of



1. Determine which sponsor group is to be displayed.

2. Display costs for the selected sponsor group items in sets of ten (or less) items. Display according to sort order.

   a. If all sponsor items have been displayed, do step 3.

   b. Display headings:

      sponsor name, cost components in model analysis

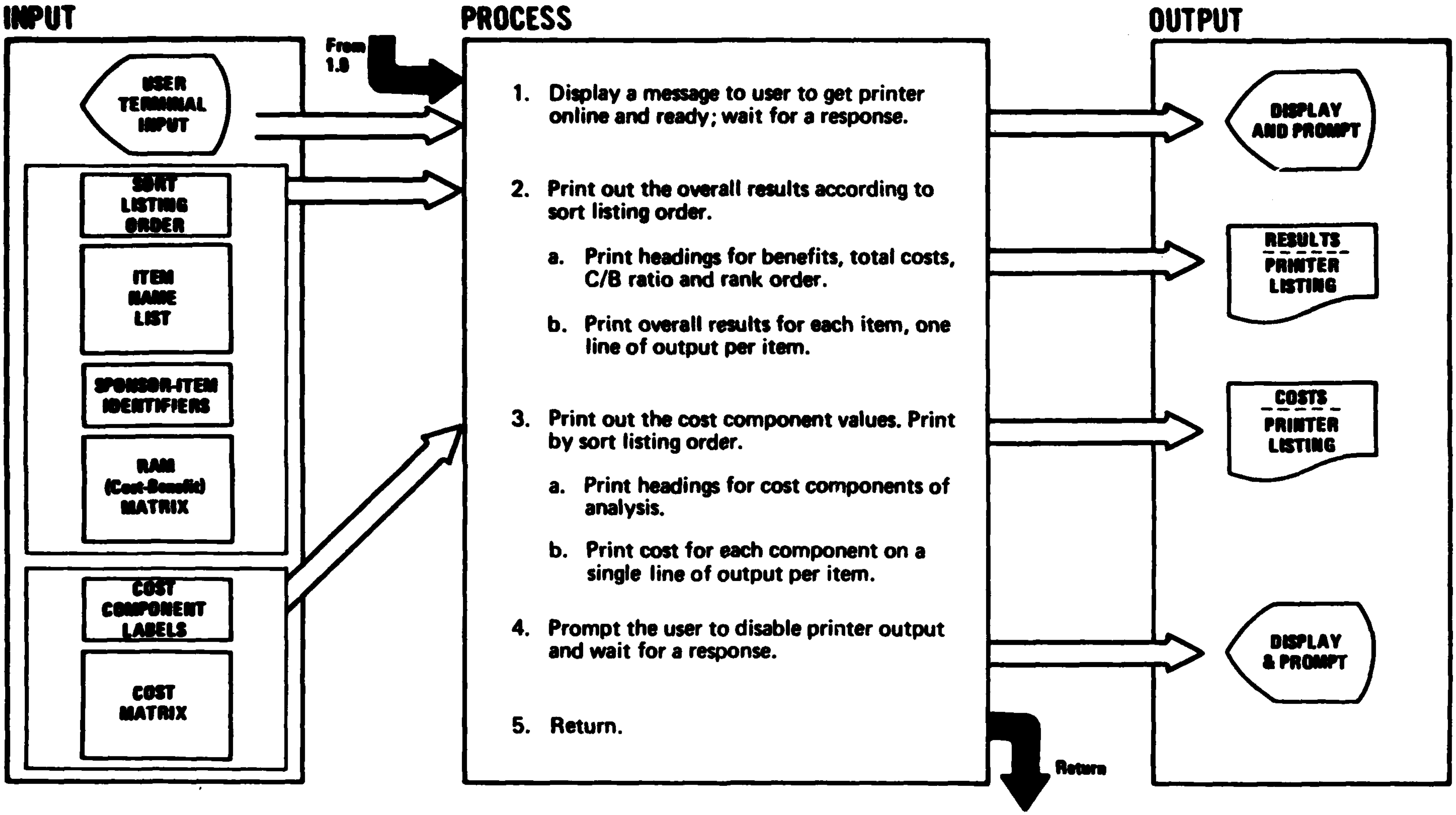
   c. Display on single line:
      - sponsor-item identifier
      - item name
      - cost for each component

   d. Prompt user for continuation. If user wants to see more, repeat from 2 with next set of items.

3. Return.

System/Program: REPRAM Name:

Diagram ID: 6.0 Description Printer Listings Page: of



1. Display a message to user to get printer online and ready; wait for a response.

2. Print out the overall results according to sort listing order.

   a. Print headings for benefits, total costs, C/B ratio and rank order.

   b. Print overall results for each item, one line of output per item.

3. Print out the cost component values. Print by sort listing order.

   a. Print headings for cost components of analysis.

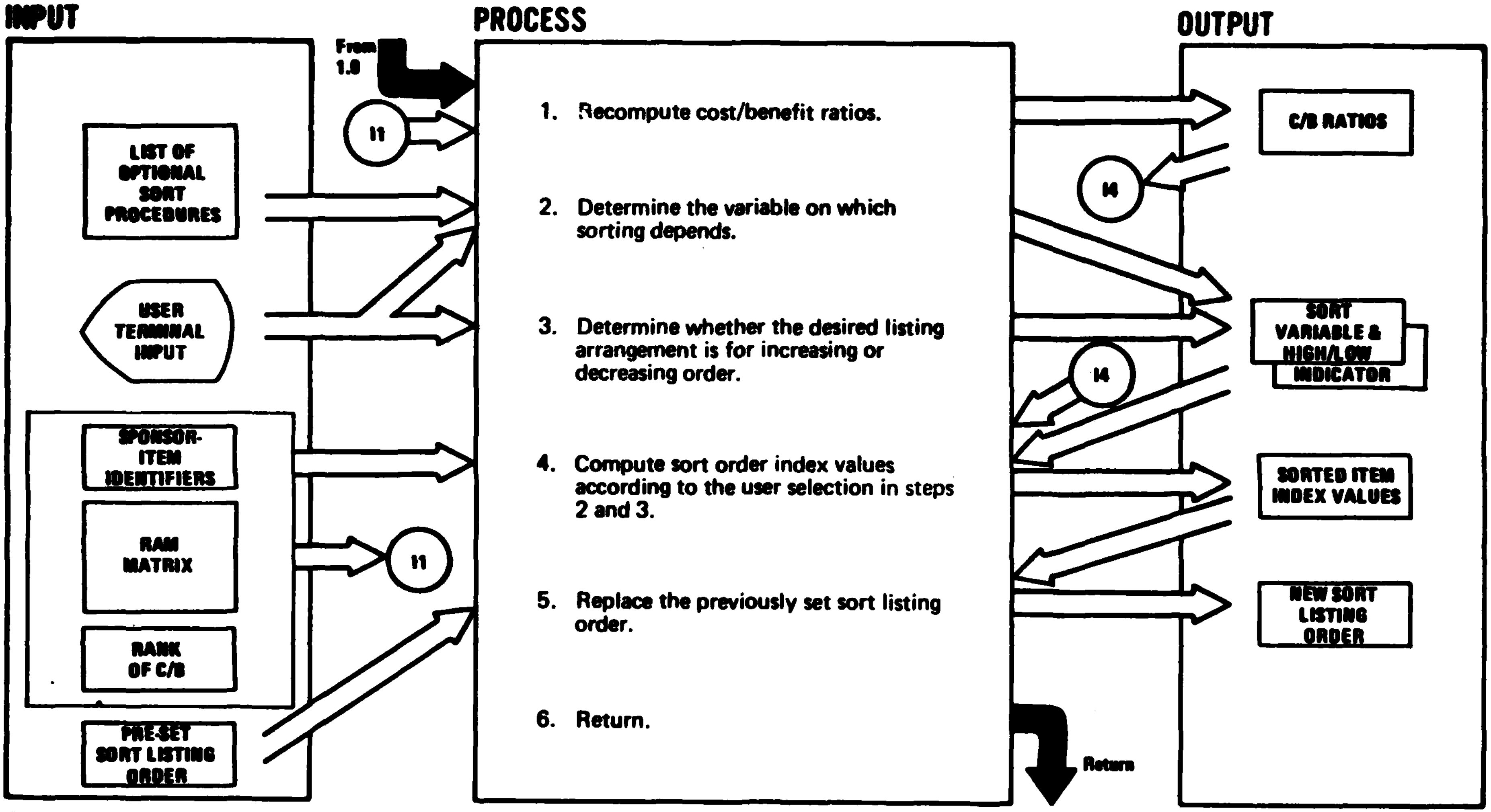
   b. Print cost for each component on a single line of output per item.

4. Prompt the user to disable printer output and wait for a response.

5. Return.

System/Program: REPRAM Name: ________

Diagram ID: 7.0 Description Sort Displays Page: ____ of ____



1. Recompute cost/benefit ratios.
2. Determine the variable on which sorting depends.
3. Determine whether the desired listing arrangement is for increasing or decreasing order.
4. Compute sort order index values according to the user selection in steps 2 and 3.
5. Replace the previously set sort listing order.
6. Return.

Extended Description

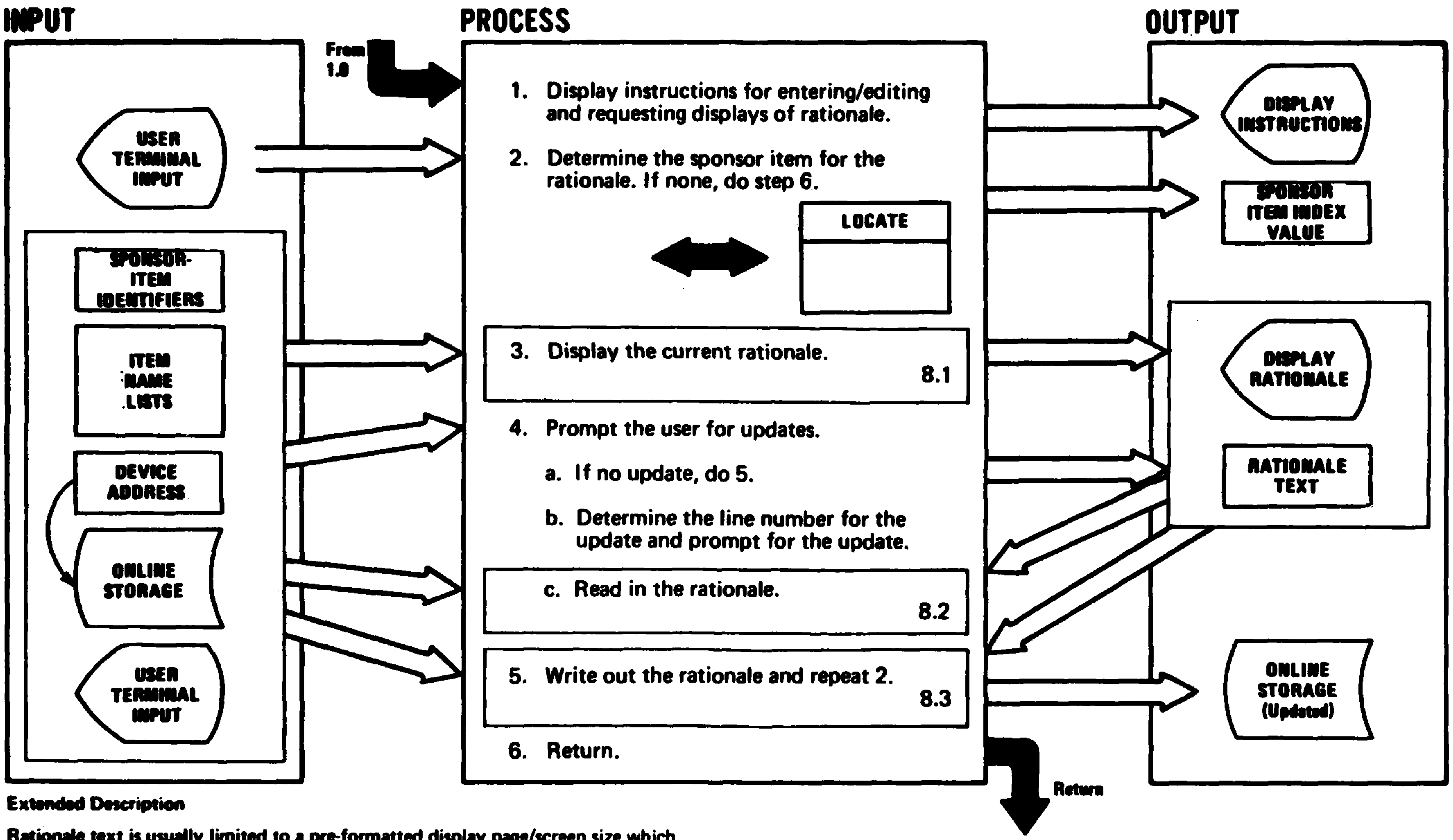
1. Editing may have changed the previous C/B ratios.

2. List of available SORT options includes the following:

a) by sponsor item number
b) by sponsor benefit value
c) overall benefit values
d) total cost values
e) cost-benefit ratio
f) rank order

System/Program: REPRAM Name:

Diagram ID: 8.0 Description Enter/Display Rationale Page: of



1. Display instructions for entering/editing and requesting displays of rationale.
2. Determine the sponsor item for the rationale. If none, do step 6.
3. Display the current rationale. 8.1
4. Prompt the user for updates.
   a. If no update, do 5.
   b. Determine the line number for the update and prompt for the update.
   c. Read in the rationale. 8.2
5. Write out the rationale and repeat 2. 8.3
6. Return.

Extended Description

Rationale text is usually limited to a pre-formatted display page/screen size which is compatible with the operating computer system.

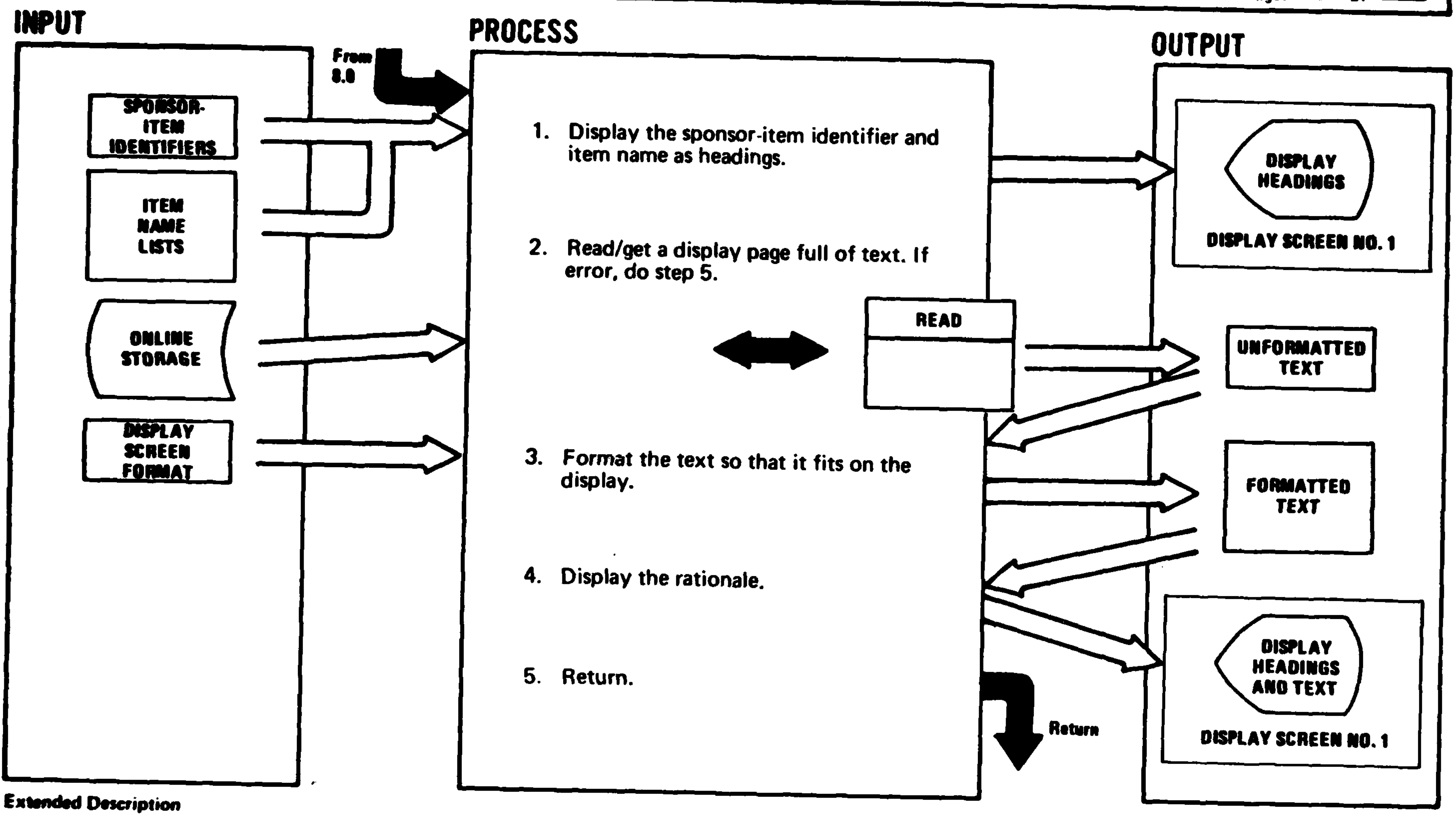
The number of lines of text available for each sponsor item (and/or the number of available pages of text) may be determined by on-site systems personnel.

2. The LOCATE subroutine is described in diagram 12.5 of the "BUILDRAM subsystem" HIPO documentation.

System/Program: REPRAM Name:

Diagram ID: 8.1 Description Display the Current Rationale

Page: ___ of ___



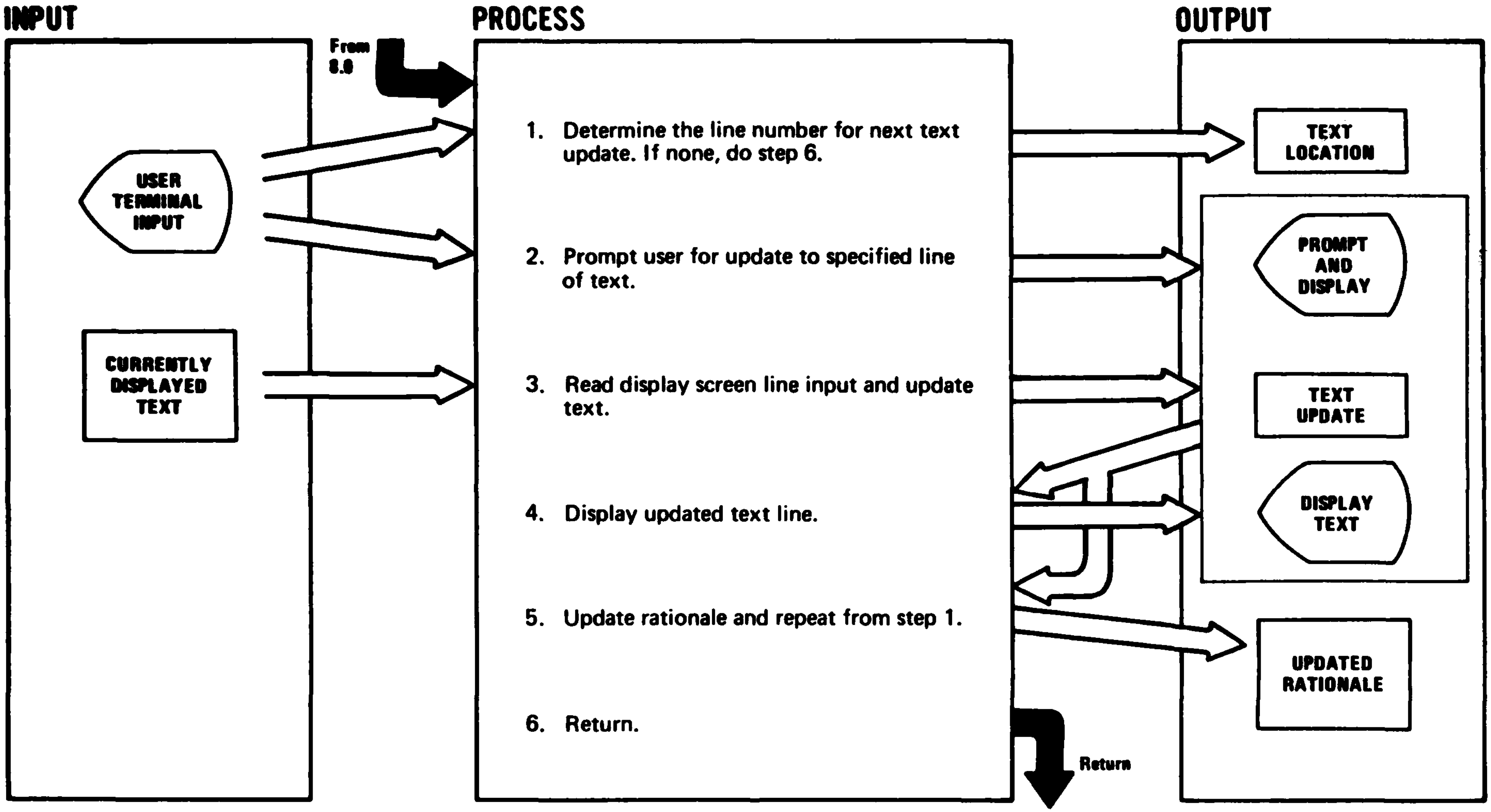
1. Display the sponsor-item identifier and item name as headings.
2. Read/get a display page full of text. If error, do step 5.
3. Format the text so that it fits on the display.
4. Display the rationale.
5. Return.

Extended Description

4. If no rationale has been specified previously for the sponsor-item, then a page/screen of blank lines should appear.

System/Program: REPRAM Name:

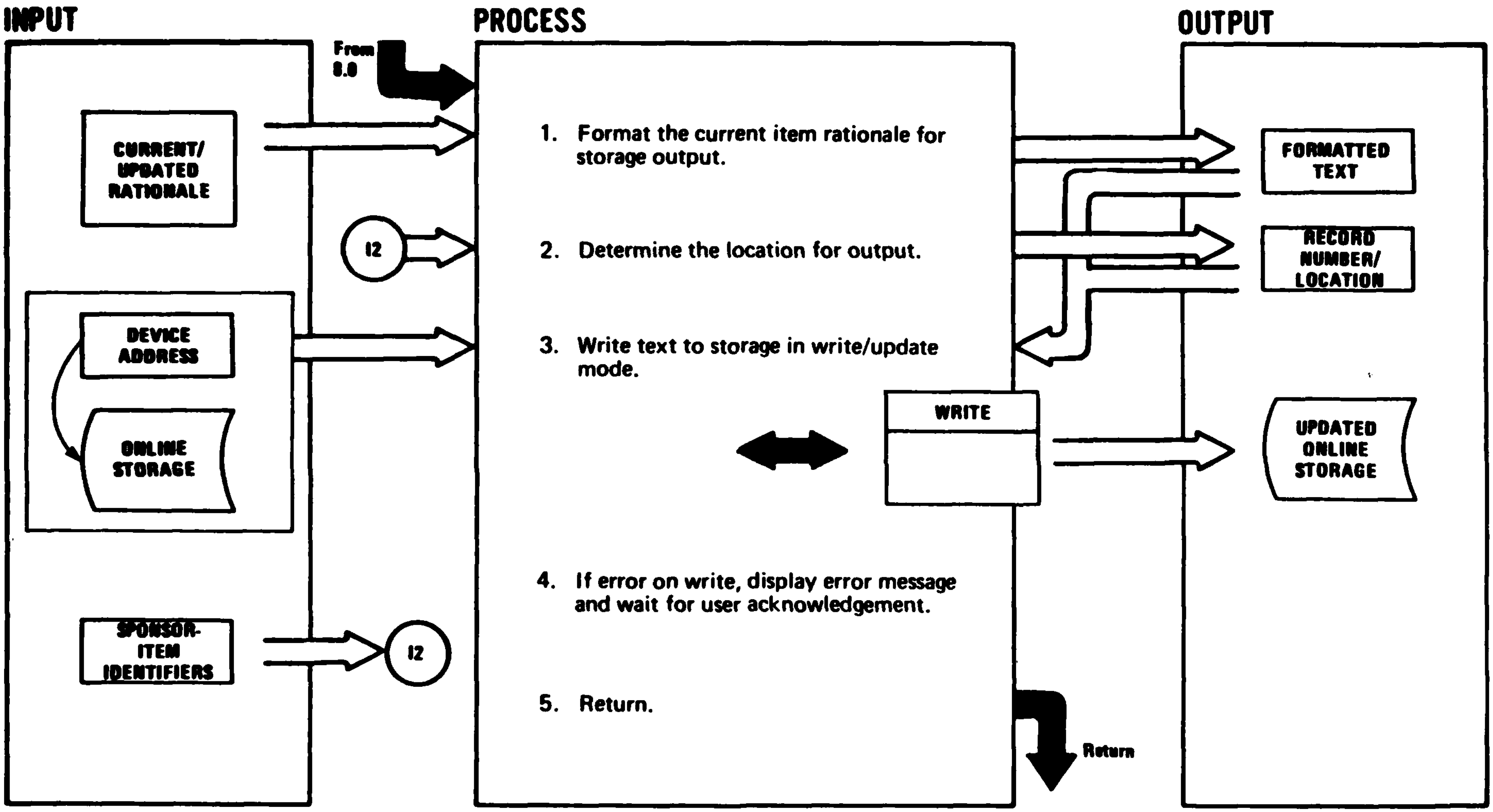
Diagram ID: 8.2 Description Read in Rationale Enter/Edit Page: of



1. Determine the line number for next text update. If none, do step 6.
2. Prompt user for update to specified line of text.
3. Read display screen line input and update text.
4. Display updated text line.
5. Update rationale and repeat from step 1.
6. Return.

System/Program: REPRAM Name: ________

Diagram ID: 8.3 Description Write Out Rationale Page: ____ of ____



1. Format the current item rationale for storage output.
2. Determine the location for output.
3. Write text to storage in write/update mode.
4. If error on write, display error message and wait for user acknowledgement.
5. Return.